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A journal of plant ecology

ROYAL BOTANIC GARDENS SYDNEY
National Herbarium of New South Wales

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COVER: Spectacular granitic outcrops are a feature of Bald Rock and Girraween National Parks, north of Tenterfield. The vegetation of outcrops on the New England Batholith is described in detail by Hunter & Clarke in this issue (pages 547–618).

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Volume 5(3) • 1998

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Allan Cunningham

CUNNINGHAMIA 5(3): 547–778 • JULY 1998

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ISSN 0727–9620

National Herbarium of New South Wales
Royal Botanic Gardens Sydney
Mrs Macquaries Road
Sydney NSW Australia 2000

The vegetation of granitic outcrop communities on the New England Batholith of eastern Australia

John T. Hunter and Peter J. Clarke

Hunter, John T. and Clarke, Peter J. (Division of Botany, University of New England, Armidale, NSW 2350) 1998. The vegetation of granitic outcrop communities on the New England Batholith of eastern Australia. Cunninghamia *5 (3): 547–618.* The vegetation of 22 areas of granitic outcrops on the New England Batholith has been surveyed using semi-quantitative quadrat sampling. In total 399 0.1 ha quadrats were placed on 216 outcrops. Twenty-eight plant communities in nine major groups and an additional unsurveyed community are circumscribed. A high number of nationally rare or threatened taxa, many of which are restricted to outcrop areas, have been found in these communities along with many taxa of special note. Previous studies have over-emphasised structure which can vary considerably with negligible floristic change. Suggestions are made on potential areas for reservation.

Introduction

Studies concentrating on the vegetation of granitic outcrops have been undertaken throughout the world (e.g. Whitehouse 1933; Oosting & Anderson 1937; McVaugh 1943; Keever et al. 1951; Keever 1957; Hambler 1964; Murdy et al. 1970; Sharitz & McCormick 1973; Rundel 1975; Shure & Fagsdale 1977; Wyatt 1977; Phillips 1981; Phillips 1982; Wyatt 1981; Baskin & Baskin 1982; Walters 1982; Burbanck & Phillips 1983; Wyatt 1984a, b; Uno & Collins 1987; Baskin & Baskin 1988; Houle & Phillips 1988; Houle & Phillips 1989a, b; Houle 1990; Porembski et al. 1994; Ibisch et al. 1995; Porembski 1995; Porembski et al. 1996). Research into outcrops, and in particular granitic outcrops, has culminated in the formation of the 'Inselberg-Projeckt' supported by the Deutsche Forschungsge-meinschaft (Porembski et al. 1994). Outcrops have been chosen worldwide for research as they constitute clearly delimited systems suited for testing hypotheses on the maintenance of biodiversity (Porembski et al. 1994). In Australia, studies involving the direct investigation of granitic outcrop vegetation have occurred particularly in Western Australia (e.g. Smith 1961; Ashton & Webb 1977; Gillham 1961; Hopper 1981; Burgman 1987; Kirkpatrick et al. 1988; Norris & Thomas 1991; Pignatti & Pignatti 1994).

The New England Batholith in eastern Australia (see Fig. 3) has approximately 175 000 ha of exposed granitic outcrops and granitic boulder fields. The batholith extends for approximately 400 km in length and 110 km in width, from Stanthorpe in Queensland to Tamworth in New South Wales (Leigh 1968). It was formed during a major period of plutonism 265–220 million years ago (Barnes et al. 1988). About 255 individual plutons form at least 20 aggregated outcropping areas (Barnes et al. 1988). These aggregated areas extend semi-continuously through the central New England Orogen (Leigh 1968; Barnes et al. 1988). This represents one of the most significant areas of granitic outcropping in Australia. Within the batholith is Bald Rock (Figs 1 & 2), the largest granitic rock (and the second largest rock) in Australia, being 150 m high, 750 m long and 500 m wide (400 ha in total) (Leigh 1968; Walker 1982).

Within Australia the unusual nature of the vegetation communities on granitic outcrops has been recognised for many years, particularly in Western Australia. Much work has been carried out recently, particularly by Stephen Hopper of Kings Park Botanic Gardens. This culminated recently, in 1996, in a public symposium on the flora and fauna of granitic outcrops, hosted by the Royal Society of Western Australia. However very few studies have described the communities on granitic outcrops in the eastern states. Beadle (1981) describes granitic outcrop communities from Western Australia and Victoria, and other rocky outcrop communities in general, however very little is written about the extensive outcrop communities on the New England Batholith, with the only statement being: 'In some areas where large granitic tors occur, some unusual species are found'. Often rocky outcrop communities have been ignored completely. For example, the Forestry Commission of New South Wales stated in 1989 that apart from lichens, mosses and some herbs established in crevasses, rocky outcrops are usually unvegetated.

Previous studies on the vegetation of the New England Batholith have examined granitic outcrop communities, although indirectly in many instances (Maiden 1906; Williams 1969; Williams 1972; Roberts 1983; Stewart 1991; Williams 1991a, b; Williams & Wissman 1991; Binns 1992; Hosking & James 1993; Williams 1994; Binns 1995; Clarke et al. 1995; Le Brocque & Benson 1995; NSW National Parks & Wildlife Service 1995; Benson & Ashby 1996; McDonald et al. 1995; Clarke et al. 1998; Hunter 1998a, b; ERM Mitchell McCotter 1998). Some of these investigations have been on particular species that occur on granitic outcrops within the New England Batholith (Benson 1992; Hunter 1992; Hunter & Williams 1994; Hunter 1995; Hunter & Bruhl 1996; Hunter et al. 1996; Richards 1996; Hunter 1997a, b, c; Richards & Hunter 1997; Hunter et al. 1998).

This paper presents an account of 29 vegetation communities that occur on granitic outcrops of the New England Batholith based on semi-quantitative sampling and numerical analysis. The complicating affects that individual taxa have on the structural description of communities either due to chance occurrence or previous fire history are discussed.

Study area

The area surveyed comprised the granitic outcrop portions of the New England Batholith and in particular those that included extensive areas of exposed granitic surfaces. Twenty-four separate areas of granitic outcropping were chosen for investigation (Fig. 3). These included all of the larger and a majority of the smaller known aggregated plutons. The outcrop areas were confined to specific aggregated plutons and thus were naturally bounded. The vegetation was surveyed on four broad types of granitic geology: granite, leucoadamellite, adamellite and granodiorite.

The study area covered four botanical divisions: North Coast, Northern Tablelands and North Western Slopes of New South Wales and the Darling Downs of Queensland.

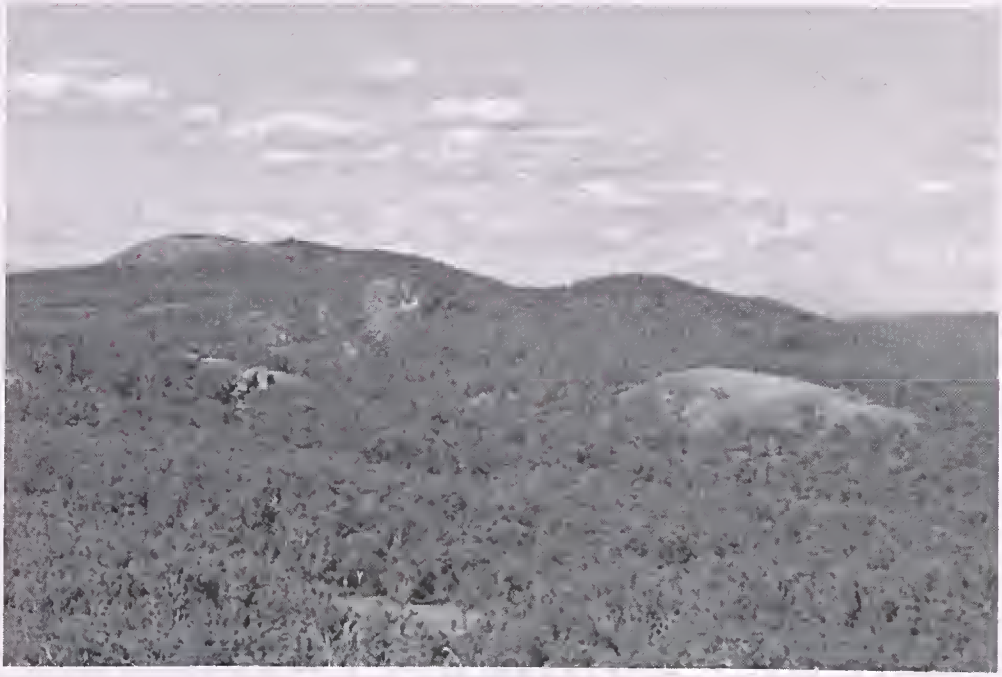

Fig. 1. View of the 'Granite Belt' of Girraween and Bald Rock National Parks from South Bald Rock. Bald Rock is the largest granitic outcrop in Australia (top left). The New South Wales–Queensland border runs along the top of the granite rocks in view.

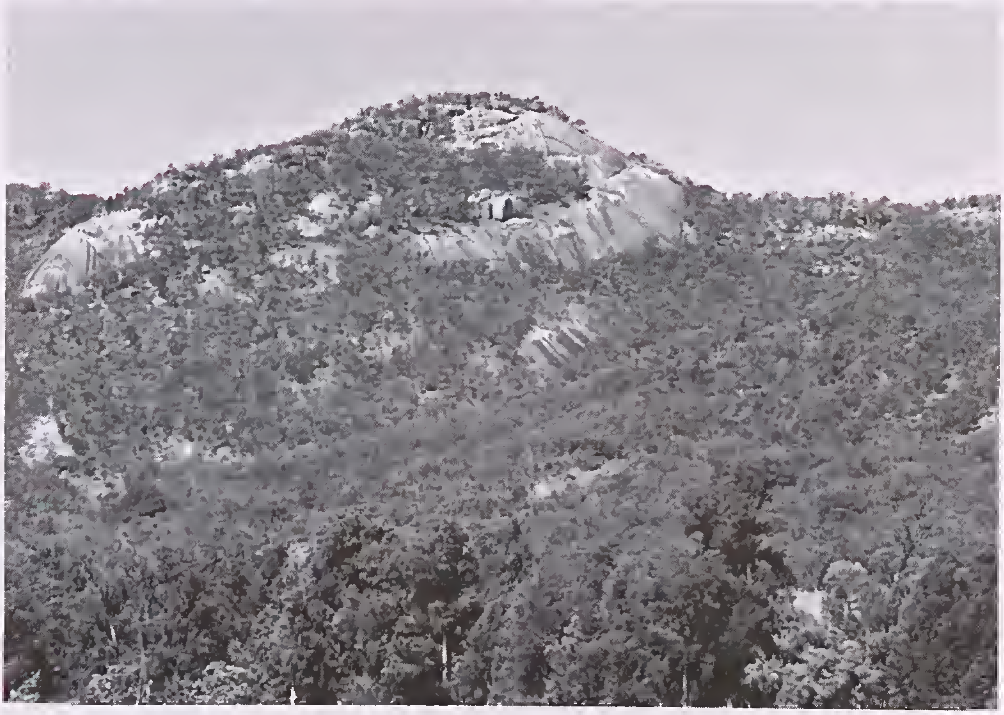

Fig. 2. Back Creek Mountain at Moore Creek Gap near Moonbi north of Tamworth is in the southern-most portion of the New England Batholith.

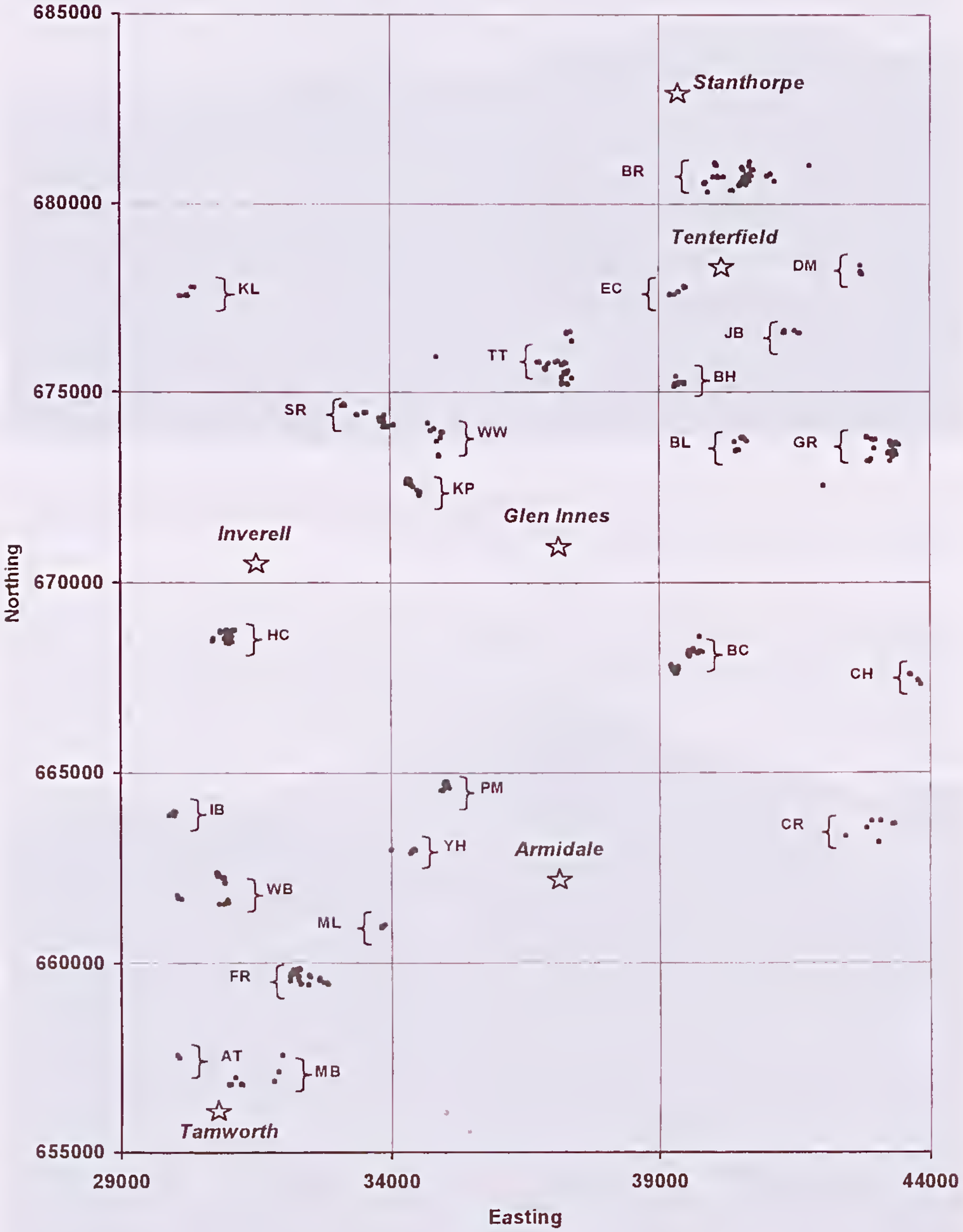

Fig 3. New England Batholith study area on the Northern Tablelands between Tamworth and Stanthorpe. Distribution of the 24 surveyed areas and placement of the 399 quadrats. The scales of the axis are in AMG coordinates. Codes to the regions surveyed are given in Table 1.

Tenure of the land included state forests, crown lands, national parks, nature reserves, travelling stock reserves, forest reserves, private reserves, private lands and various forms of leasehold land. General aspects of the 24 areas investigated are given in Table 1.

The New England Batholith generally reaches its highest elevation on the eastern escarpment and becomes lower towards the west. Kwiambal and Cathedral Rock National Parks represent extremes of climate in the area surveyed (Table 1). Kwiambal National Park had altitudes as low as 310 m above sea level. Here the rainfall is as low as 642 mm a year, the mean temperature of the hottest month is 31.9°C and the mean temperature of the coldest month is 11.4°C. Sites within Cathedral Rock National Park were at altitudes as high as 1520 m above sea level. The rainfall at Cathedral Rock is up to 1490 mm per year, the mean temperature of the hottest month is 21°C and the mean temperature of the coldest month is 4.2°C.

Granitic outcrops support the major natural vegetation remnants in some districts. Even on land in private ownership, areas with granitic outcrops are commonly left relatively unmodified in comparison to the pasture lands on other geological strata and landforms.

Methods

Sampling and stratification

The survey was conducted between April 1994 and June 1996, using 32 m × 32 m (0.1 ha) nested quadrats. The nested quadrat design was first described by Bunce and Shaw (1973) and initially tested by Outhred (1984). This method is based on a series of smaller (nested) quadrats that decrease in size geometrically within a larger quadrat. Studies by Outhred (1984), Outhred et al. (1985), Le Brocque and Buckney (1995), Morrison et al. (1995a) and Morrison et al. (1995b) have shown this method capable of detecting subtle community patterns by being functionally equivalent to frequency and directly related to plant density. The method was modified to enable approximately 0.1 ha to be surveyed and a frequency score of 10 be given to each taxon found. At the time of the survey, 0.1 ha was considered a standard size for vegetation surveys. Each quadrat was marked out by the placement of four 30 m measuring tapes marking the diagonals. Markings were placed on the measuring tapes at distances from the centre of the quadrat at 1, 1.4, 2, 2.8, 4, 5.7, 8, 11.2, 16 and 22.5 m. This divided the total quadrat into 10 subquadrats of approximate cumulative area: 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1024 m^2. All vascular plant species were recorded for each quadrat. The presence or absence of a taxon in each of the ten subquadrats gave a frequency score out of ten for each taxon, providing a measure of relative abundance. This same alteration in design has been used by Clarke et al. (1998) and ERM Mitchell McCotter (1998) for vegetation surveys in north-east New South Wales.

The 24 granitic outcrop areas were identified from satellite and aerial photographs, local knowledge, and topographic and geological maps (Table 1). Choice of outcrops and sites was also influenced by access. The area of land covered by each outcropping area was estimated by examination of the aerial photographs and topographic maps.

Table 1: Selected attributes of the 24 granitic outcrop areas chosen for the survey. Tenure codes = SF: State Forest, PR: Private Free Hold, NP: National Park, SFR: State Forest Reserve, NR: Nature Reserve, SRA: State Recreation Area, TSR: Traveling Stock Reserve, LC: Leasehold.

Name	Geology	Altitude (m)	Annual Precipitation (mm)	Area (ha)	Locality	Tenure
Attunga (AT)	Adamellite	430–930	703–705	900	16 km NW Tamworth	SF
Backwater (BC)	Leucoadamellite	800–1372	889–979	5000	40 km SE Glen Innes	PR, SF, SFP
Bald Rock & Girraween (BR)	Adamellite	800–1277	832–972	26 000	20 km N Tenterfield	NP
Bolivia Hill (BH)	Leucoadamellite	950–1225	832–882	2000	15 km N Deepwater	PR
Butterleaf (BL)	Granite	900–1300	1002–1054	6000	40 km NE Glen Innes	PR, SF, SFP
Cathedral Rock (CR)	Leucoadamellite	1000–1580	1021–1490	3000	70 km E Armidale	NP
Demon Nature Reserve (DM)	Adamellite	470–1090	1250–1300	900	30 km E of Tenterfield	NR
Mount Chaelundi (CH)	Granite	900–1377	1168–1356	800	40 km N Ebor	NP, SF
Eagle Creek (EC)	Adamellite	700–1118	798–860	1500	12 km SW Tenterfield	PR
Flaggy Range (FR)	Adamellite	750–1149	753–838	5000	10 km N Bendemeer	PR
Gibraltar Range (GR)	Granite	900–1175	1118–1447	10 000	60 km E Glen Innes	NP, SF, LC
Howell (HC)	Granite	600–934	752–866	6500	5 km SW Tingha	PR, LC, CR
Ironbark (IB)	Leucoadamellite	640–1019	780–840	2500	25 km SW Bundarra	NR, PR
Mount Jondol (JB)	Leucoadamellite	1100–1210	943–1041	800	22 km SE Tenterfield	SF

Name	Geology	Altitude (m)	Annual Precipitation (mm)	Area (ha)	Locality	Tenure
Kwiambal (KL)	Granite	280–460	642–672	2500	30 km W Ashford	NP, PR, SF
Kings Plains (KP)	Undifferentiated	850–1009	759–793	2500	40 km NW Glen Innes	NP
Moonbi (MB)	Adamellite	550–980	740–875	2500	5 km W Moonbi	PR, TSR
Mount Balala (ML)	Adamellite	850–980	765–784	500	16 km SW Uralla	PR
Parlour Mountain (PM)	Leucoadamellite	1070–1200	844–888	2500	35 km NW Armidale	PR
Severn River (SR)	Undifferentiated	500–740	678–709	5500	50 km NW Glen Innes	NR, P
Torrington (TT)	Granite	400–1220	745–815	40 000	60 km NW Glen Innes	SRA, LC
Warrabah (WB)	Leucoadamellite	430–1042	671–832	6000	15 km W Kingstown	NP, PR
The Willows (WW)	Undifferentiated	700–850	710–726	1500	40 km NW Glen Innes	PR
Mount Yarrowyck (YH)	Granodiorite	800–1205	812–758	1500	25 km W Armidale	NR, PR

One hectare of exposed rock could be easily identified from aerial photographs and was chosen as the minimum size of outcrop to be surveyed. This size also enabled the placement of a 0.1 ha square quadrat without undesirable edge effects. The number of quadrats allocated to the 24 areas and individual outcrops was based on surface area then transformed on a logarithmic scale. The use of a logarithmic scale enabled more equitable distribution of quadrats. A total of 399 quadrats were surveyed on 216 separate granitic outcrops (Fig. 3).

To enable comparative analyses to be performed on the vegetation occurring on and off outcrops an additional 123 quadrats were surveyed in forests and woodlands surrounding the outcrops. This research is not presented here but will be incorporated in subsequent publications. The endemic status of the granite outcrop taxa was assessed on the basis of the additional forest and woodland quadrats and other available data including field observations and herbarium records.

Data analysis

The site data are stored on a relational database held by one of the authors (JTH). Analyses and data exploration were performed using options available in the PATN Analysis Package (Belbin 1995a, b). Analyses were performed using Bray & Curtis, Canberra Metric and Kulczynski association measures in combination with flexible UPGMA using positive and negative ß values. Additional analyses were performed both with or without species which were recorded only once, as presence/absence data or with full abundance scores. For final presentation of results all species and their relative abundance scores were used and the analysis was performed using the Kulczynski association measure which is recommended for ecological applications (Belbin 1995a, b) along with flexible UPGMA and the default PATN settings.

Nomenclature

Species lists were compiled solely from work carried out during this survey. Lists of rare and threatened species were compiled from the national ROTAP listing maintained by the National Parks and Wildlife Service together with relevant updates from recent publications (Appendix 1). Accepted botanical names are listed in Appendix 2.

Community names are based on the two most frequently important (sum of all abundance scores) native taxa in the most consistent dominant stratum. Structural names follow Specht et al. (1995) and are based on the most consistent uppermost stratum.

Names of geological strata are based on relevant geological maps (New South Wales Geological Survey 1971, 1984, 1986, 1987a–c, 1988a–f, 1992a, b, 1993; New South Wales Department of Mines 1971, 1973a, b, 1976; New South Wales Department of Mineral Resources 1974, 1987). Not all strata have been named or dated and as such are only named by their broad granitic type (i.e. undifferentiated leucoadamellite etc.).

Results

Floristics

In total 671 vascular plant taxa from 307 genera and 99 families were recorded during the survey of granite outcrops. Approximately 27% of the taxa were considered as predominantly occurring on granitic outcrops within the region. Only 38 taxa were exotic in origin, representing 6% of the total flora surveyed. The most common exotic taxa were *Hypochaeris radicata, Bidens pilosa, Opuntia aurantiaca, Conyza bonariensis,* and *Trifolium repens*.

The ten most commonly encountered taxa on granitic outcrops on the New England Batholith were: *Cheilanthes sieberi* subsp. *sieberi* (55% of sites), *Entolasia stricta* (48%), *Leucopogon neo-anglicus* (45%), *Trachymene incisa* (42%), *Hypochaeris radicata* (40%), *Tripogon loliiformis* (39%), *Lepidosperma laterale* (38%), *Aristida jerichoensis* (37%), *Gonocarpus teucrioides* (36%) and *Leptospermum novae-angliae* (36%). Eight of the ten most commonly occurring taxa were herbaceous in nature, and only two represented shrubby taxa. Ten or more taxa were found in four genera: *Acacia* (35), *Eucalyptus* (24), *Pterostylis* (13) and *Hibbertia* (13). Ten or more taxa were found in 13 families: Fabaceae (74), Poaceae (64), Myrtaceae (58), Asteraceae (55), Orchidaceae (36), Cyperaceae (24), Epacridaceae (23), Proteaceae (23), Rutaceae (21), Euphorbiaceae (20), Lamiaceae (15), Dilleniaceae (13) and Apiaceae (10).

Plant Communities

A summarised dendrogram produced by the Kulczynski association measure and flexible UPGMA clustering is shown in Fig. 5. Twenty-eight vascular plant communities were defined in nine major elements (Figs 4 & 5). The nine elements were defined by the analysis at the dissimilarity level of 1.00. These nine elements coincided with the intuitive assessment of the authors. There was an additional 29th community that was totally distinct, but was not quantitatively sampled due to its rarity and inaccessibility.

In the following list of plant communities up to ten taxa are listed for each growth-form category. These taxa are listed in decreasing order of summed abundances within each community. The listing of restricted taxa is also based on decreasing summed abundances. Overall fidelity (percentage of quadrats) within the community is also given within brackets next to each taxon.

Element 1: Glen Innes Shrubby Open Scrubs and Closed Heaths

These communities are restricted to high altitude areas north and south-east of Glen Innes. Structurally they are mainly closed heaths although the mallee *Eucalyptus codonocarpa* may be present forming shrubby open scrubs. Occasionally other tree species occur, such as *Eucalyptus andrewsii, Eucalyptus campanulata, Eucalyptus williamsiana,* and *Eucalyptus cameronii*, giving a shrubby low open woodland structure. In some instances *Leptospermum novae-angliae* at its tallest and densest will form closed scrub (Fig. 6).

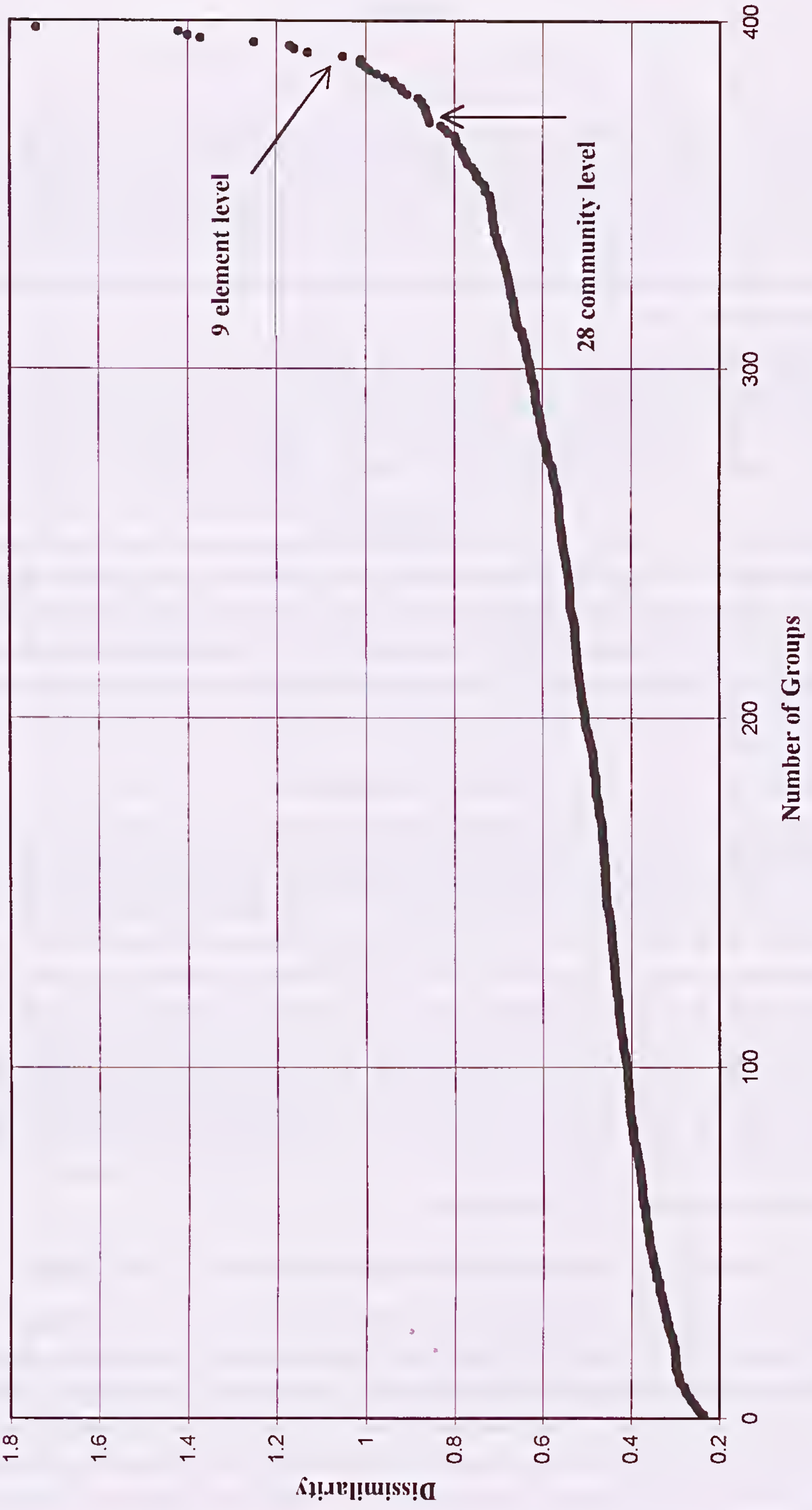

Fig. 4. Screen Plot of Kulczynski association measure and the flexible UPGMA fusion strategy results based on all sites surveyed (399 in total).

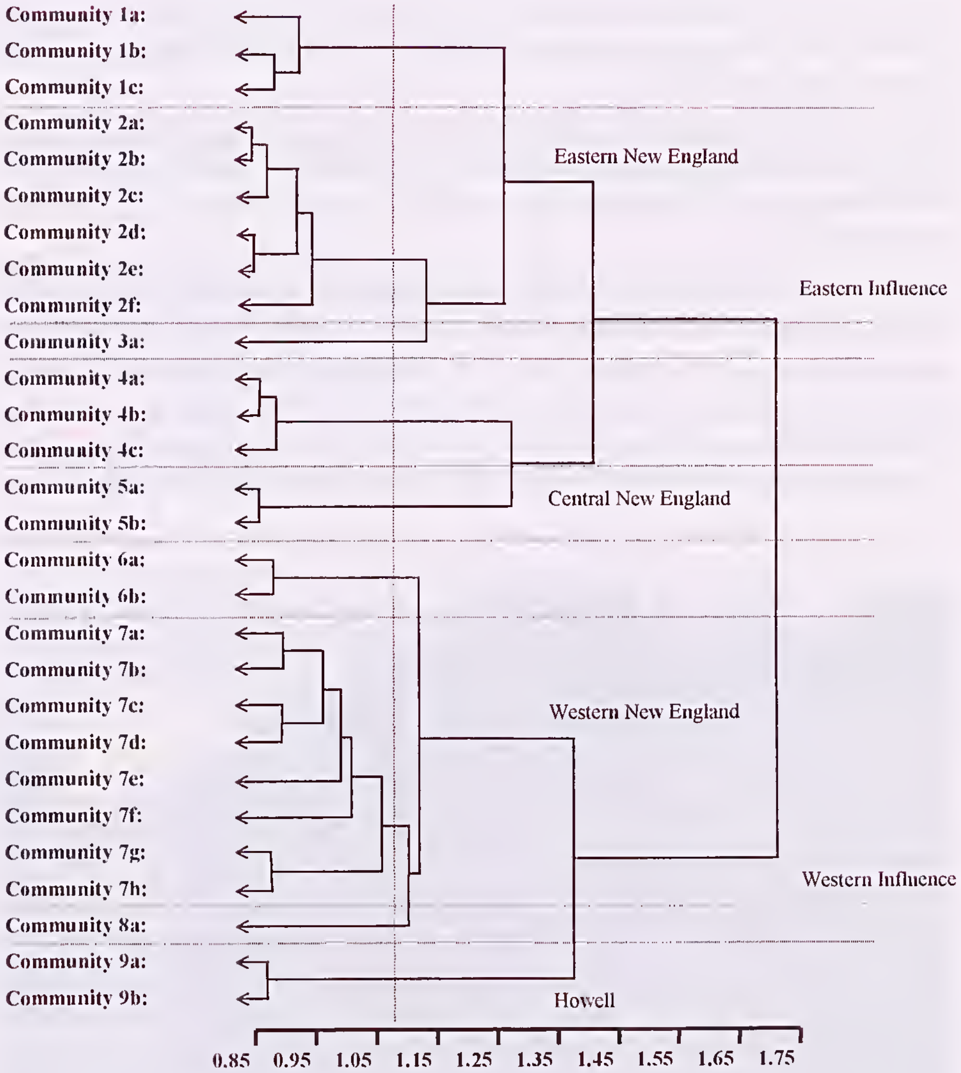

Fig. 5. Summary dendrogram of 28 floristic communities in nine major elements found on granitic outcrops on the New England Batholith, based on Kulczynski association and flexible UPGMA fusion.

Community 1a: ***Leptospermum novae-angliae–Kunzea obovata*** **heath (Warra Heaths)**

Geology: Oban River Leucoadamellite.

Trees: *Eucalyptus codonocarpa* (56%), *Eucalyptus acaciiformis* (38%), *Eucalyptus caliginosa* (31%).

Shrubs: *Platysace lanceolata* (94%), *Leptospermum novae-angliae* (100%), *Kunzea obovata* (94%), *Leucopogon neo-anglicus* (81%), *Allocasuarina rigida* subsp. *rigida* (69%), *Acacia ulicifolia* (81%), *Acacia venulosa* (63%), *Mirbelia confertiflora* (69%), *Hovea* sp. A (88%), *Dillwynia phylicoides* (63%).

Herbs: *Entolasia stricta* (100%), *Monotaxis macrophylla* (75%), *Gonocarpus teucrioides* (75%), *Muehlenbeckia costata* (69%), *Lepidosperma gunnii* (75%), *Actinotus gibbonsii* (81%), *Schoenus apogon* (81%), *Stypandra glauca* (56%), *Dampiera stricta* (56%), *Gonocarpus micranthus* (50%).

Restricted taxa: *Monotaxis macrophylla, Muehlenbeckia costata, Mirbelia confertiflora, Eucalyptus codonocarpa, Brachyloma saxicola, Phebalium ambiens, Phebalium ozothamnoides.*

Threats and conservation status: This community has been little degraded and almost all surveyed occurrences are within Crown Mountain Flora Reserve (Warra State Forest) and adjacent private properties. No occurrences are reserved in National Parks. A large-scale *Cannabis* plantation burnt out in 1994, and has caused disturbance within

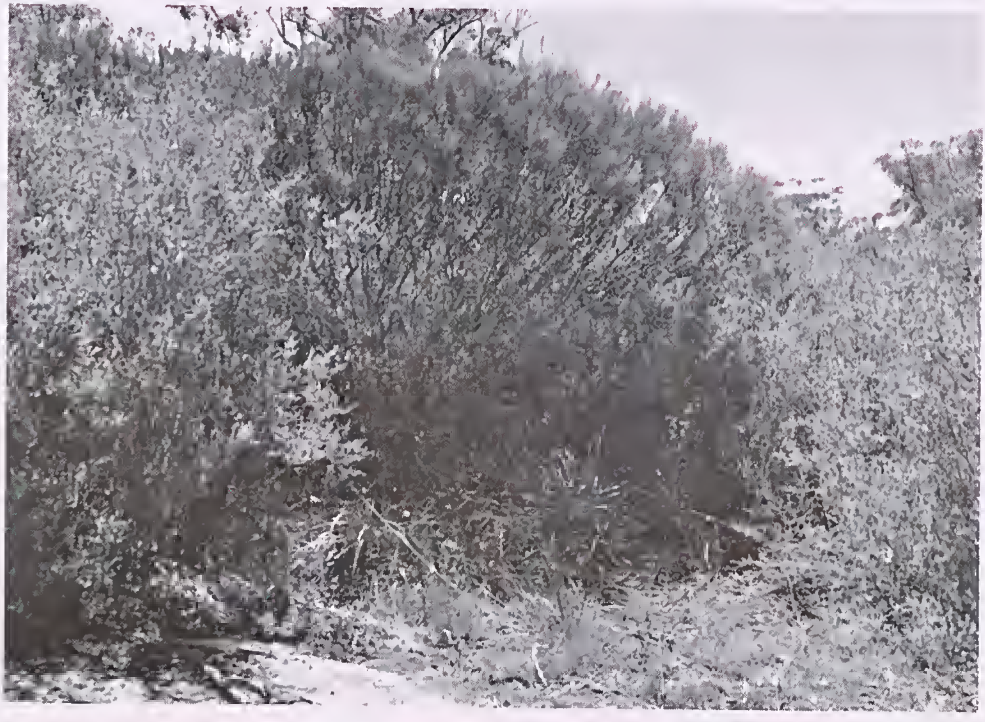

Fig. 6. Element 1. *Leptospermum nova-angliae–Kunzea obovata* and is typical of the high altitude areas around Crown Mountain, Backwater and Butterleaf.

the Reserve including outcropping areas. This habitat is potentially threatened by goats, grazing of domestic stock, and hobby farm subdivisions that are near Warra State Forest.

Community 1b: *Kunzea obovata* heath (Butterleaf Heaths)

Geology: Kingsgate Granite & Oban River Leucoadamellite.

Trees: *Eucalyptus codonocarpa* (39%), *Eucalyptus andrewsii* (15%), *Eucalyptus williamsiana* (15%), *Eucalyptus campanulata* (8%), *Allocasuarina littoralis* (54%).

Shrubs: *Leucopogon neo-anglicus* (85%), *Kunzea obovata* (92%), *Leptospermum novae-angliae* (77%), *Eriostemon myoporoides* subsp. *epilosus* (77%), *Brachyloma saxicola* (69%), *Calytrix tetragona* (31%), *Hibbertia riparia* (31%), *Acacia viscidula* (39%), *Allocasuarina rigida* subsp. *rigida* (39%), *Acacia venulosa* (54%), *Epacris microphylla* (23%).

Herbs: *Brachyscome stuartii* (85%), *Schoenus apogon* (92%), *Lepidosperma gunnii* (85%), *Entolasia stricta* (77%), *Gonocarpus micranthus* (54%), *Austrodanthonia monticola* (46%), *Cheilanthes sieberi* subsp. *sieberi* (46%), *Trachymene incisa* (39%), *Gonocarpus oreophilus* (46%), *Empodisma minus* (54%).

Restricted taxa: *Eriostemon myoporoides* subsp. *epilosus*, *Brachyloma saxicola*, *Eucalyptus codonocarpa*, *Leucopogon cicatricatus*, *Cryptandra lanosiflora*, *Mirbelia confertiflora*, *Muehlenbeckia costata*, *Monotaxis macrophylla*, *Lasiopetalum ferrugineum* var. *cordatum*.

Threats and conservation status: Much of this community is in private ownership. However Mount Scott, one of the largest outcrops on the New England Batholith, is within Butterleaf State Forest, parts of which have been designated as preserved native forest by the State Forests of New South Wales. One site also occurs within Crown Mountain Flora Reserve. This community is not reserved in National Parks. The community may be threatened by disturbance from goats and grazing of domestic stock.

Community 1c: *Leptospermum novae-angliae* Heath (Backwater Heaths)

Geology: Oban River Leucoadamellite.

Trees: *Eucalyptus codonocarpa* (36%), *Eucalyptus caliginosa* (18%), *Eucalyptus dalrympleana* (5%).

Shrubs: *Leptospermum novae-angliae* (96%), *Leucopogon neo-anglicus* (91%), *Kunzea obovata* (91%), *Brachyloma saxicola* (91%), *Prostanthera scutellarioides* (77%), *Allocasuarina rigida* subsp. *rigida* (68%), *Calytrix tetragona* (64%), *Mirbelia confertiflora* (86%), *Hibbertia acicularis* (74%), *Boronia anemonifolia* (64%).

Herbs: *Lepidosperma gunnii* (82%), *Gonocarpus teucrioides* (86%), *Entolasia stricta* (82%), *Brachyscome stuartii* (73%), *Austrodanthonia monticola* (68%), *Lomandra longifolia* (59%), *Gahnia sieberiana* (55%), *Empodisma minus* (36%), *Trachymene incisa* (55%), *Schoenus apogon* (59%).

Restricted taxa: *Brachyloma saxicola*, *Mirbelia confertiflora*, *Cryptandra lanosiflora*, *Eucalyptus codonocarpa*, *Pseudanthus divaricatissimus*, *Thelionema grande*, *Cyphanthera albicans* subsp. *albicans*.

Threats and conservation status: No sites of this community type are known within the current reservation system. Off-park reservation is provided by a conservation agreement on the property 'Wattleridge'. Community 1c is potentially threatened by change in land ownership, hobby farms, goats and grazing by domestic stock.

Element 2: New England Escarpment Shrubby Open Scrubs and Heaths

Structurally these communities are mainly closed heaths. As with element one the mallee *Eucalyptus codonocarpa* may be present, giving the appearance of shrubby open scrubs. Similarly many other eucalypt species may sporadically occur such as *Eucalyptus cameronii*, *Eucalyptus andrewsii*, *Eucalyptus banksii* and *Eucalyptus caliginosa* giving a shrubby low open woodland structure. Occasionally *Leptospermum novae-angliae* at its tallest and densest will form closed scrub. This element is widespread along the eastern escarpment of the New England Batholith from north of Tenterfield to east of Armidale.

Community 2a: *Leptospermum novae-angliae–Brachyloma saxicola* Heathland (Escarpment Heaths)

Geology: Kingsgate Granite, Chaelundi Complex — Granite, Stanthorpe Adamellite, Dandahra Creek Granite.

Trees: *Eucalyptus codonocarpa* (20%), *Eucalyptus cameronii* (20%), *Eucalyptus bridgesiana* (20%), *Eucalyptus andrewsii* (20%), *Eucalyptus campanulata* (20%), *Eucalyptus scias* subsp. *apoda* (20%), *Allocasuarina torulosa* (20%).

Shrubs: *Leptospermum novae-angliae* (60%), *Leucopogon neo-anglicus* (40%), *Brachyloma saxicola* (80%), *Boronia anethifolia* (60%), *Monotoca scoparia* (100%), *Kunzea bracteolata* (20%), *Pimelea linifolia* (60%), *Callitris monticola* (20%), *Acacia falciformis* (40%), *Leucopogon lanceolatus* (80%), *Acrotriche aggregata* (20%).

Herbs: *Lomandra longifolia* (100%), *Gonocarpus oreophilus* (80%), *Entolasia stricta* (100%), *Patersonia sericea* (60%), *Xanthorrhoea glauca* (40%), *Trachymene incisa* (60%), *Lepidosperma neesii* (20%), *Caustis flexuosa* (20%), *Stylidium laricifolium* (20%), *Dianella tasmanica* (60%).

Restricted taxa: *Brachyloma saxicola*, *Kunzea bracteolata*, *Eucalyptus codonocarpa*, *Muehlenbeckia costata*, *Bertya cunninghamii*, *Eriostemon myoporoides* subsp. *epilosus*, *Leucopogon cicatricatus*, *Acacia floydii*, *Acianthus apprimus*, *Eucalyptus scias* subsp. *apoda*.

Threats and conservation status: Four of the five sites surveyed are reserved. The sites are within Gibraltar Range National Park, Guy Fawkes River National Park and Demon Nature Reserve, and one of the sites at Butterleaf State Forest is within preserved native forest under the control of State Forests of New South Wales. Patches on private land are little disturbed, although areas close to cleared grazing lands are prone to disturbance from cattle and the spread of weeds.

Community 2b: *Acacia viscidula–Kunzea opposita* Heath (Jondol Heaths)

Geology: Billyrimba Leucoadamellite.

Trees: *Eucalyptus andrewsii* (100%), *Allocasuarina littoralis* (75%), *Eucalyptus brunnea* (25%).

Shrubs: *Acacia viscidula* (100%), *Leucopogon neo-anglicus* (100%), *Kunzea opposita* (75%), *Platysace lanceolata* (75%), *Leptospermum novae-angliae* (75%), *Prostanthera nivea* (50%), *Brachyloma saxicola* (75%), *Zieria cytisoides* (50%), *Acrotriche aggregata* (100%), *Mirbelia speciosa* subsp. *speciosa* (50%).

Herbs: *Lomandra longifolia* (100%), *Trachymene incisa* (100%), *Entolasia stricta* (75%), *Stylidium laricifolium* (75%), *Gonocarpus teucrioides* (75%), *Austrodanthonia linkii* (50%), *Laxmannia compacta* (50%), *Bulbostylis densa* (75%), *Stypandra glauca* (50%), *Digitaria breviglumis* (50%).

Restricted taxa: *Brachyloma saxicola*, *Persoonia rufa*, *Phebalium dentatum*.

Threats and conservation status: This community not known to be within any reserve. Forest Lands State Forest was recently logged in 1994; however the outcrops within it are relatively undisturbed.

Community 2c: *Leptospermum novae-angliae–Leucopogon cicatricatus* Heath (Round Mountain Heaths)

Geology: Round Mountain Leucoadamellite.

Trees: *Eucalyptus caliginosa* (67%), *Banksia integrifolia* (33%).

Shrubs: *Leptospermum novae-angliae* (100%), *Leucopogon cicatricatus* (100%), *Leucopogon neo-anglicus* (100%), *Epacris microphylla* (67%), *Monotoca scoparia* (67%), *Platysace lanceolata* (100%), *Leucopogon lanceolatus* (67%), *Comesperma sylvestre* (33%), *Prostanthera scutellarioides* (33%), *Elaeocarpus holopetalus* (33%).

Herbs: *Trachymene incisa* (100%), *Carex gaudichaudiana* (100%), *Eragrostis brownii* (67%), *Trachymene incisa* (33%), *Poa sieberiana* (100%), *Brachyscome stuartii* (33%), *Lepidosperma laterale* (100%), *Dianella caerulea* (33%), *Austrodanthonia monticola* (33%), *Gahnia sieberiana* (100%).

Restricted species: *Leucopogon cicatricatus*, *Eucalyptus codonocarpa*.

Threats and conservation status: All sites surveyed are within Cathedral Rock National Park. Due to the dissected nature of these outcrops, visitor impact is minimal despite high visitor frequency in some areas.

Community 2d: *Leptospermum novae-angliae–Acacia latisepala* Heath (Granite Belt Heaths)

Geology: Stanthorpe Adamellite, Billyrimba Leucoadamellite.

Trees: *Eucalyptus andrewsii* (32%), *Eucalyptus banksii* (29%), *Eucalyptus prava* (13%), *Eucalyptus campanulata* (6%), *Eucalyptus scias* subsp. *apoda* (6%), *Callitris endlicheri* (6%), *Eucalyptus dealbata* (6%), *Eucalyptus scoparia* (3%).

Shrubs: *Eriostemon myoporoides* subsp. *epilosus* (61%), *Leptospermum novae-angliae* (71%), *Acacia latisepala* (55%), *Dodonaea viscosa* (48%), *Acacia adunca* (26%), *Leptospermum polygalifolium* subsp. *transmontanum* (58%), *Leucopogon neo-anglicus* (45%), *Kunzea bracteolata* (29%), *Leucopogon melaleucoides* (48%), *Phebalium rotundifolium* (23%).

Herbs: *Lomandra longifolia* (100%), *Entolasia stricta* (87%), *Trachymene incisa* (84%), *Gonocarpus oreophilus* (61%), *Lepidosperma laterale* (55%), *Brachyscome stuartii* (29%), *Calandrinia pickeringii* (36%), *Digitaria breviglumis* (35%), *Stylidium laricifolium* (45%), *Stypandra glauca* (32%).

Restricted taxa: *Eriostemon myoporoides* subsp. *epilosus*, *Acacia latisepala*, *Acacia adunca*, *Kunzea bracteolata*, *Phebalium rotundifolium*, *Muehlenbeckia costata*, *Phebalium ambiens*, *Prostanthera* sp. B, *Thelionema grande*, *Callitris monticola*, *Eucalyptus scias* subsp. *apoda*, *Plectranthus suaveolens*, *Homoranthus papillatus*, *Homoranthus lunatus*, *Callistemon flavovirens*, *Acacia floydii*, *Acacia macnuttiana*.

Threats and conservation status: This community is reserved within Girraween, Bald Rock and Bonoo Boonoo National Parks and Demon Nature Reserve.

Community 2e: *Leptospermum novae-angliae–Dodonaea viscosa* Heathland (Granite Belt Heaths)

Geology: Stanthorpe Adamellite.

Trees: *Allocasuarina littoralis* (14%), *Eucalyptus codonocarpa* (14%), *Eucalyptus campanulata* (29%), *Eucalyptus banksii* (14%), *Eucalyptus dalrympleana* (14%).

Shrubs: *Leptospermum novae-angliae* (86%), *Eriostemon myoporoides* subsp. *epilosus* (86%), *Dodonaea viscosa* (57%), *Acacia viscidula* (57%), *Acacia venulosa* (29%), *Kunzea bracteolata* (29%), *Leptospermum variable* (14%), *Plectranthus suaveolens* (14%), *Acrotriche aggregata* (29%), *Leucopogon lanceolatus* subsp. *lanceolatus* (43%).

Herbs: *Schoenus apogon* (100%), *Lepidosperma laterale* (86%), *Entolasia stricta* (71%), *Trachymene incisa* (71%), *Brachyscome stuartii* (100%), *Gonocarpus oreophilus* (57%), *Bulbostylis densa* (43%), *Austrodanthonia linkii* (43%), *Gonocarpus micranthus* (29%), *Actinotus gibbonsii* (29%).

Restricted taxa: *Eriostemon myoporoides* subsp. *epilosus*, *Kunzea bracteolata*, *Plectranthus suaveolens*, *Thelionema grande*, *Acacia latisepala*, *Eucalyptus codonocarpa*, *Homoranthus papillatus*, *Mirbelia confertiflora*, *Muehlenbeckia costata*, *Callitris monticola*, *Phebalium ambiens*.

Threats and conservation status: This community is reserved in Girraween and Bald Rock National Parks.

Community 2f: *Kunzea bracteolata–Leucopogon melaleucoides* Heathland (Granite Belt Heaths) (Fig. 7)

Geology: Stanthorpe Adamellite.

Trees: *Callitris endlicheri* (33%), *Eucalyptus banksii* (10%), *Eucalyptus dealbata* (14%), *Eucalyptus prava* (5%), *Eucalyptus radiata* (5%), *Eucalyptus campanulata* (5%), *Eucalyptus codonocarpa* (5%), *Eucalyptus dalrympleana* (5%), *Eucalyptus scoparia* (5%).

Shrubs: *Kunzea bracteolata* (100%), *Leucopogon neoanglicus* (90%), *Eriostemon myoporoides* subsp. *epilosus* (76%), *Leucopogon melaleucoides* (81%), *Phebalium ambiens* (29%), *Leptospermum novae-angliae* (38%), *Acacia adunca* (29%), *Callistemon pallidus* (24%), *Pimelea linifolia* (19%), *Leptospermum polygalifolium* subsp. *transmontanum* (24%).

Herbs: *Trachymene incisa* (100%), *Lomandra longifolia* (95%), *Lepidosperma laterale* (52%), *Brachyscome stuartii* (52%), *Entolasia stricta* (43%), *Crassula sieberiana* (43%), *Schoenus apogon* (29%), *Thelionema grande* (38%), *Gahnia sieberiana* (38%), *Gonocarpus teucrioides* (24%).

Restricted taxa: *Kunzea bracteolata*, *Eriostemon myoporoides* subsp. *epilosus*, *Thelionema grande*, *Phebalium ambiens*, *Acacia adunca*, *Phebalium rotundifolium*, *Acacia latisepala*, *Leucopogon cicatricatus*, *Prostanthera* sp. B, *Callitris monticola*, *Eucalyptus codonocarpa*, *Eucalyptus scoparia*, *Muehlenbeckia costata*, *Plectranthus suaveolens*.

Threats and conservation status: This community is reserved within Girraween and Bald Rock National Parks.

Element 3: Gibraltar Range Shrubby Open Scrubs and Heaths

This community is composed mainly of heaths although the mallee, *Eucalyptus codonocarpa*, is present in a few localities forming shrubby open scrub. Tree species such as *Eucalyptus notabilis*, *Eucalyptus ligustrina*, *Eucalyptus radiata* and *Eucalyptus acaciiformis* may occur giving the appearance of shrubby low open woodland structure.

Community 3a: ***Kunzea bracteolata–Leptospermum novae-angliae*** **Heath (Gibraltar Range Heaths)**

Geology: Dandahra Creek Granite.

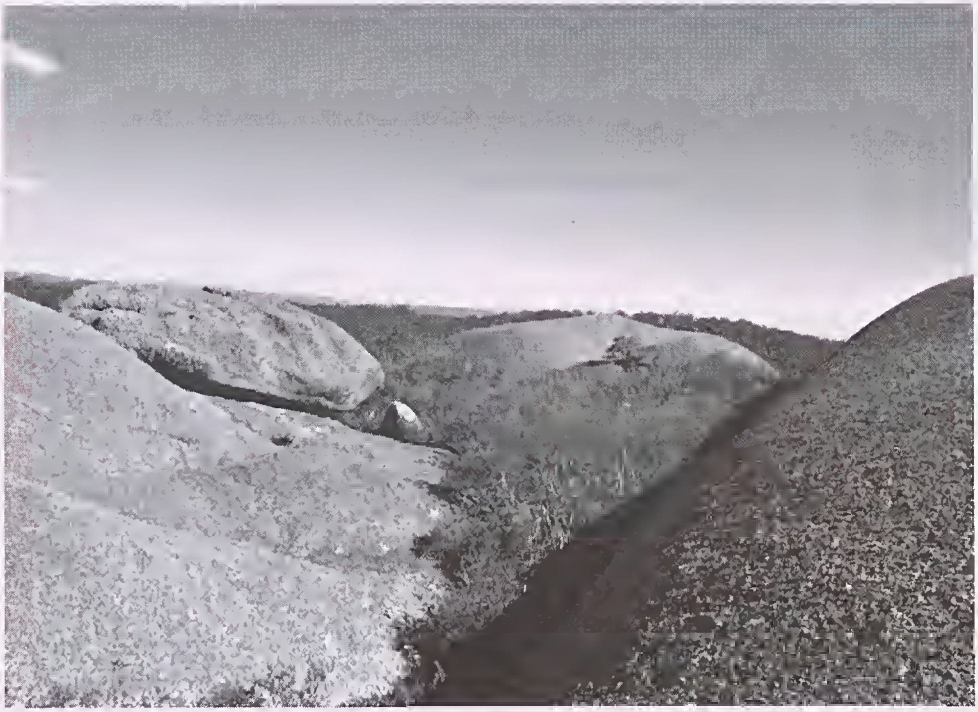

Fig. 7. Community 2f. *Kunzea obovata–Leucopogon melaleucoides* are common dominants. This community is typical of the high altitude areas near Bald Rock, Boonoo Boonoo and Girraween National Parks.

Trees: *Eucalyptus codonocarpa* (35%), *Eucalyptus notabilis* (35%), *Eucalyptus ligustrina* (35%), *Eucalyptus radiata* (4%), *Eucalyptus acaciiformis* (4%).

Shrubs: *Kunzea bracteolata* (91%), *Leucopogon neo-anglicus* (87%), *Leptospermum novae-angliae* (87%), *Callistemon comboynensis* (65%), *Calytrix tetragona* (57%), *Allocasuarina rigida* subsp. *rigida* (78%), *Platysace ericoides* (57%), *Grevillea acerata* (65%), *Epacris microphylla* (39%).

Herbs: *Lepidosperma gunnii* (87%), *Lepidosperma laterale* (91%), *Entolasia stricta* (96%), *Trachymene incisa* (83%), *Laxmannia compacta* (83%), *Lomandra longifolia* (65%), *Schoenus melanostachys* (39%), *Aristida ramosa* (52%), *Xanthorrhoea glauca* (65%), *Schoenus apogon* (48%).

Restricted taxa: *Grevillea acerata, Mirbelia confertiflora, Acacia brunioides* subsp. *brunioides, Brachyloma saxicola, Eucalyptus codonocarpa, Persoonia rufa, Callitris monticola, Cryptandra lanosiflora, Acacia* sp. aff. *torringtonensis, Hibbertia villosa, Phebalium dentatum, Acacia barringtonensis.*

Threats and conservation status: This community occurs within Gibraltar Range National Park and in most instances is relatively undisturbed. Some localities have had minor damage by stray cattle from neighbouring properties.

Element 4: Central New England Shrublands

Low shrubs dominate these communities which are more open in structure than the previous two elements and form shrubby low open shrublands. Taller shrubs such as *Acacia pycnostachya, Leptospermum novae-angliae* and *Kunzea bracteolata* may be present but they rarely dominate as they do in elements one and two. *Callitris endlicheri* and various eucalypt species such as *Eucalyptus prava* may also be present, giving the appearance of shrubby low open woodland. The latter structure is particularly apparent at Torrington where the granite outcrops are highly dissected.

Community 4a: *Leucopogon neo-anglicus–Micromyrtus sessilis* Low Shrubland (Bolivia Hill Shrublands)

Geology: Bolivia Range Leucoadamellite, Chaelundi Complex (Granite), Mount Mitchell Adamellite (Porphyritic).

Trees: *Callitris endlicheri* (50%), *Eucalyptus prava* (36%), *Eucalyptus caliginosa* (14%), *Eucalyptus dealbata, Eucalyptus bridgesiana* (7%).

Shrubs: *Leucopogon neo-anglicus* (100%), *Micromyrtus sessilis* (100%), *Kunzea bracteolata* (71%), *Boronia anethifolia* (71%), *Kunzea obovata* (57%), *Leptospermum novae-angliae* (36%), *Acacia viscidula* (57%), *Acacia pycnostachya* (64%), *Leptospermum brevipes* (36%), *Cryptandra lanosiflora* (43%).

Herbs: *Digitaria breviglumis* (100%), *Gonocarpus teucrioides* (100%), *Austrodanthonia monticola* (79%), *Entolasia stricta* (93%), *Bulbostylis densa* (100%), *Lepidosperma laterale* (86%), *Brachyscome stuartii* (86%), *Tripogon loliiformis* (79%), *Cheilanthes sieberi* subsp. *sieberi* (86%), *Lepidosperma gunnii* (64%).

Restricted taxa: *Kunzea bracteolata, Acacia pycnostachya, Cryptandra lanosiflora, Eriostemon myoporoides* subsp. *epilosus, Brachyloma saxicola, Acacia adunca, Mirbelia confertiflora, Boronia boliviensis, Thelionema grande, Homoranthus croftianus* m.s.

Threats and conservation status: This community is almost entirely in freehold ownership with only minor occurrences in Guy Fawkes River National Park. The community is relatively undisturbed but is threatened by feral goats and changes in ownership. The area is under investigation for purchase by the National Parks and Wildlife Service of New South Wales.

Community 4b: *Prostanthera staurophylla–Kunzea bracteolata* Low Shrubland (Torrington Shrublands)

Geology: Mole Granite (rarely porphyritic).

Trees: *Eucalyptus prava* (90%), *Callitris endlicheri* (66%), *Eucalyptus andrewsii* (26%), *Acacia neriifolia* (11%), *Eucalyptus dealbata* (5%).

Shrubs: *Leucopogon neo-anglicus* (100%), *Prostanthera staurophylla* (82%), *Kunzea bracteolata* (53%), *Leptospermum novae-angliae* (58%), *Leucopogon melaleucoides* (74%), *Acacia viscidula* (55%), *Brachyloma saxicola* (58%), *Hibbertia sp.* B (55%), *Micromyrtus sessilis* (24%), *Calytrix tetragona* (21%).

Herbs: *Brachyscome stuartii* (84%), *Entolasia stricta* (87%), *Tripogon loliiformis* (79%), *Digitaria breviglumis* (79%), *Lepidosperma laterale* (68%), *Laxmannia compacta* (74%), *Gonocarpus teucrioides* (50%), *Cheilanthes sieberi* subsp. *sieberi* (79%), *Aristida jerichoensis* (63%), *Isotoma axillaris* (53%).

Restricted taxa: *Prostanthera staurophylla, Kunzea bracteolata, Brachyloma saxicola, Hibbertia* sp. B, *Phebalium rotundifolium, Phebalium glandulosum* subsp. *eglandulosum, Acacia latisepala, Dodonaea hirsuta, Eriostemon myoporoides* subsp. *epilosus, Micrantheum ericoides, Boronia granitica, Melichrus erubescens, Acacia granitica, Persoonia terminalis* subsp. *terminalis, Phebalium ambiens, Pseudanthus pimeleoides, Acacia macnuttiana, Acacia torringtonensis, Acacia betchei, Hakea macrorhyncha, Pultenaea stuartiana, Homoranthus lunatus, Acacia williamsiana.*

Threats and conservation status: This community occurs within Torrington State Recreation Area under the management of the New South Wales National Parks and Wildlife Service. This reserve is at present a multi-purpose reserve that allows many activities to occur and reservation is not as secure as a formal Nature Reserve or National Park. Much of the land has been disturbed in the past by mining, grazing and, in some places, frequent fires. Some mining leases are still under option and may be taken up.

Community 4c: *Babingtonia odontocalyx–Brachyloma saxicola* Shrubland (Torrington Woodlands) (Fig. 8)

Geology: Mole Granite.

Trees: *Eucalyptus prava* (100%), *Callitris endlicheri* (100%), *Eucalyptus andrewsii* (100%).

Shrubs: *Babingtonia odontocalyx* (100%), *Brachyloma saxicola* (100%), *Leptospermum brevipes* (100%), *Leucopogon biflorus* (100%), *Leucopogon melaleucoides* (100%), *Boronia anethifolia* (50%), *Hibbertia obtusifolia* (50%), *Hibbertia* sp. B (50%), *Styphelia triflora* (100%), *Acacia falciformis* (50%).

Herbs: *Entolasia stricta* (100%), *Calandrinia eremaea* (50%), *Juncus remotiflorus* (50%), *Lobelia gracilis* (50%), *Patersonia sericea* (100%), *Pomax umbellata* (50%), *Trachymene incisa* (100%), *Asplenium flavellifolium* (50%), *Davallia pyxidata* (50%), *Dianella revoluta* (50%)

Restricted taxa: *Babingtonia odontocalyx, Brachyloma saxicola, Hibbertia* sp. B., *Boronia granitica, Persoonia terminalis* subsp. *terminalis, Phebalium rotundifolium.*

Threats and conservation status: The community is conserved within the Torrington State Recreation Area. Grazing and inappropriate fire regimes are threats to this community. Although only sampled here by two sites this community is apparently very common in the south-western areas of the Torrington pluton (Clarke et al. 1998).

Element 5: Severn Shrublands

These communities are restricted to the north-west of Glen Innes. *Leucopogon neo-anglicus* and *Calytrix tetragona* often dominate forming low open shrublands, or taller species may be present, such as *Allocasuarina brachystachya, Allocasuarina inophloia, Acacia williamsiana* or *Micromyrtus grandis,* giving a shrubby tall shrubland structure.

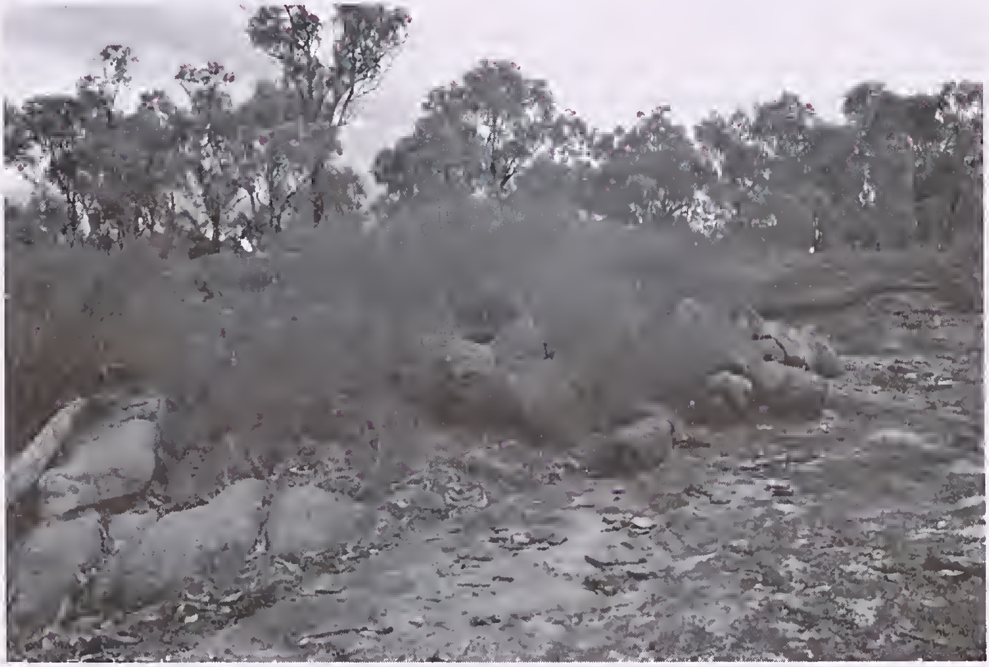

Fig. 8. Community 4c. This community is dominated by *Acacia granitica* but usually *Babingtonia odontocalyx–Brachyloma saxicola* are more common. This community is common the south-western parts of the Torrington State Recreation Area.

If *Eucalyptus prava*, *Eucalyptus caleyi* or *Callitris endlicheri* are present a shrubby low open woodland structure is apparent.

Community 5a: ***Calytrix tetragona–Leptospermum novae-angliae*** **Shrubland (Kings Plains Shrublands)** (Fig. 9)

Geology: Undifferentiated.

Trees: *Callitris endlicheri* (61%), *Eucalyptus prava* (70%), *Eucalyptus caleyi* (22%), *Acacia neriifolia* (9%), *Eucalyptus albens* (4%), *Eucalyptus crebra* (4%), *Eucalyptus dealbata* (4%), *Eucalyptus mckieana* (4%).

Shrubs: *Leucopogon neo-anglicus* (96%), *Calytrix tetragona* (91%), *Leptospermum novae-angliae* (100%), *Melichrus urceolatus* (78%), *Cryptandra amara* var. *floribunda* (74%), *Kunzea obovata* (52%), *Allocasuarina brachystachya* (48%), *Leucopogon attenuatus* (70%), *Hibbertia riparia* (44%), *Homoranthus biflorus* (30%).

Herbs: *Tripogon loliiformis* (96%), *Aristida jerichoensis* (96%), *Cheilanthes sieberi* (91%), *Digitaria breviglumis* (87%), *Fimbristylis dichotoma* (74%), *Trachymene incisa* (83%), *Lepidosperma laterale* (87%), *Laxmannia compacta* (83%), *Entolasia stricta* (78%), *Goodenia bellidifolia* (57%).

Restricted taxa: *Allocasuarina brachystachya, Homoranthus biflorus, Acacia torringtonensis, Micromyrtus grandis, Acacia williamsiana, Boronia granitica, Phebalium rotundifolium, Astrotricha roddii, Callistemon pungens, Hibbertia* sp. B, *Zieria odorifera, Eucalyptus mckieana.*

Threats and conservation status: Conservation of this community occurs in Kings Plains National Park and Severn River Nature Reserve. Threats to the community include grazing on private property and feral goats across all tenures.

Community 5b: ***Allocasuarina brachystachya*** **Shrubland (Severn Shrublands)** (Fig. 10)

Geology: Undifferentiated.

Trees: *Eucalyptus prava* (82%), *Eucalyptus caleyi* (64%), *Callitris endlicheri* (27%), *Eucalyptus dealbata* (9%).

Shrubs: *Calytrix tetragona* (100%), *Allocasuarina brachystachya* (100%), *Leucopogon attenuatus* (91%), *Leptospermum novae-angliae* (100%), *Cryptandra amara* var. *floribunda* (91%), *Melichrus urceolatus* (91%), *Aotus subglauca* (91%), *Leucopogon neo-anglicus* (55%), *Acacia torringtonensis* (91%), *Hibbertia riparia* (73%).

Herbs: *Pterostylis daintreana* (82%), *Schoenus apogon* (91%), *Austrodanthonia monticola* (100%), *Goodenia bellidifolia* (91%), *Aristida jerichoensis* (100%), *Trachymene incisa* (82%), *Drosera peltata* (91%), *Entolasia stricta* (82%), *Cheilanthes sieberi* subsp. *sieberi* (82%), *Lepidosperma laterale* (82%).

Restricted taxa: *Allocasuarina brachystachya, Acacia torringtonensis, Persoonia terminalis* subsp. *terminalis, Phebalium rotundifolium, Astrotricha roddii, Hibbertia* sp. B, *Acacia williamsiana.*

Threats and conservation status: This community occurs in Severn River Nature Reserve. This reserve is relatively inaccessible and undisturbed, however feral goats are known in the area. Cattle, sheep and goats graze on neighbouring properties.

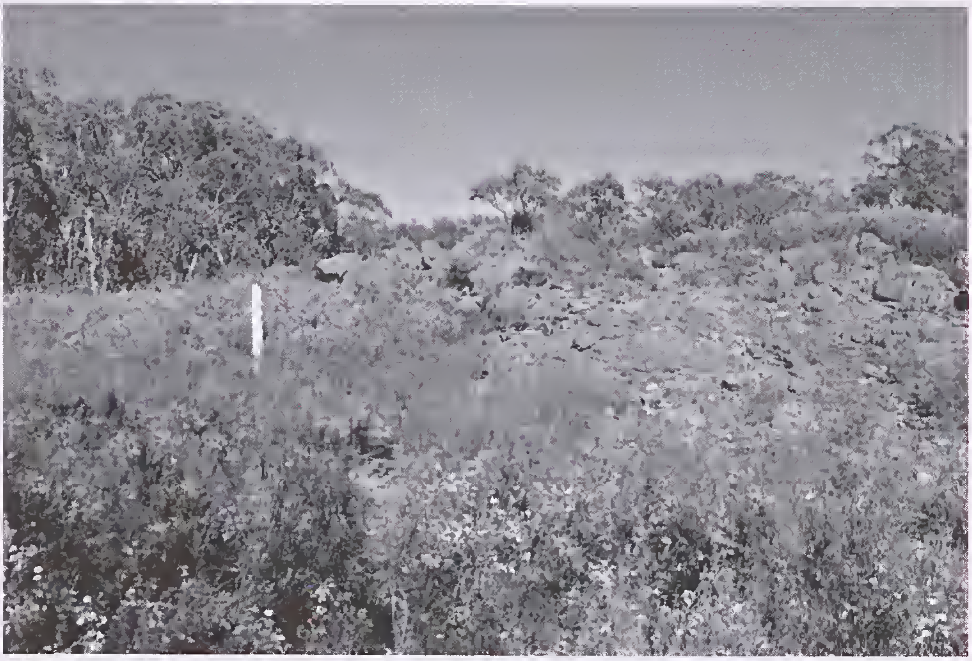

Fig. 9. Community 5a. *Leucopogon neo-anglicus–Calytrix tetragona* are common dominants in Kings Plains National Park, Severn River Nature Reserve and private properties along the Severn River.

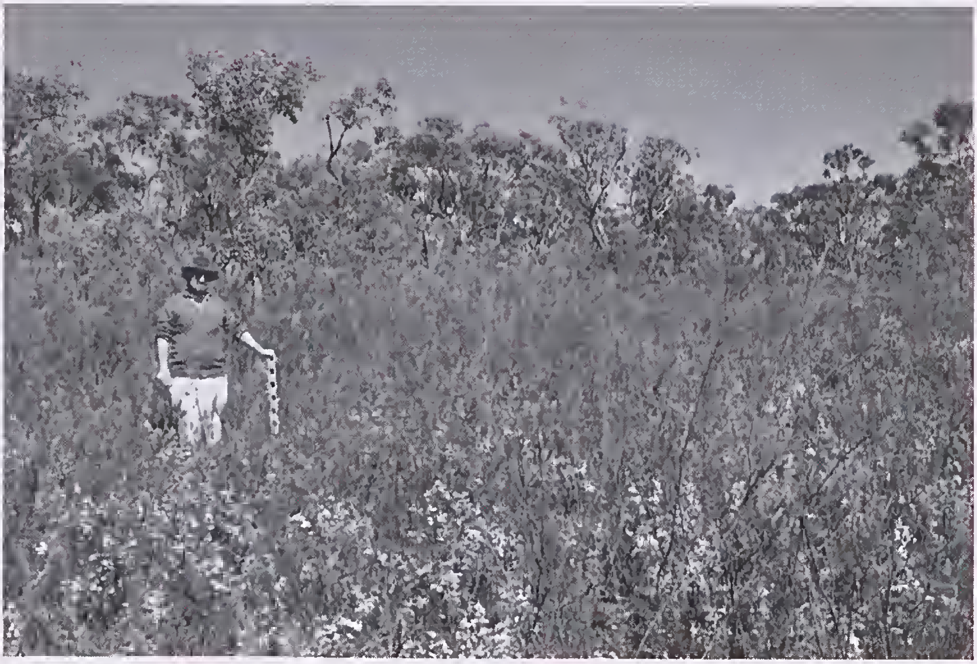

Fig. 10. Community 5b. This unusual community is dominated by *Allocasuarina brachystachya* and is found within Kings Plains National Park and Severn River Nature Reserve.

Element 6: Moonbi Shrublands and Grasslands

These communities are found north and northwest of Tamworth. Those to the west are mainly graminoid while those near Moonbi often have a shrub component. Occasionally species such as *Eucalyptus prava*, *Ficus rubiginosa*, *Callitris endlicheri*, or *Callitris glaucophylla* may be present, giving the structural appearance of shrubby open scrub or grassy low open woodland. *Triodia scariosa* is also present in patches in the Moonbi area.

Community 6a: *Cymbopogon refractus–Tripogon loliiformis* Grassland (Attunga Grasslands) (Fig. 11)

Geology: Attunga Creek Adamellite.

Trees: *Eucalyptus prava* (50%), *Callitris endlicheri* (100%).

Shrubs: *Canthium odoratum* (100%), *Desmodium brachypodum* (50%), *Melichrus urceolatus* (50%), *Notelaea microcarpa* (50%), *Alphitonia excelsa* (50%), *Swainsona galegifolia* (50%).

Herbs: *Cymbopogon refractus* (100%), *Tripogon loliiformis* (100%), *Digitaria brownii* (100%), *Cheilanthes distans* (100%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Glycine clandestina* (100%), *Paspalidium constrictum* (100%), *Dichondra* sp. A (100%), *Aristida ramosa* (50%), *Aristida vagans* (50%).

Restricted taxa: none recorded.

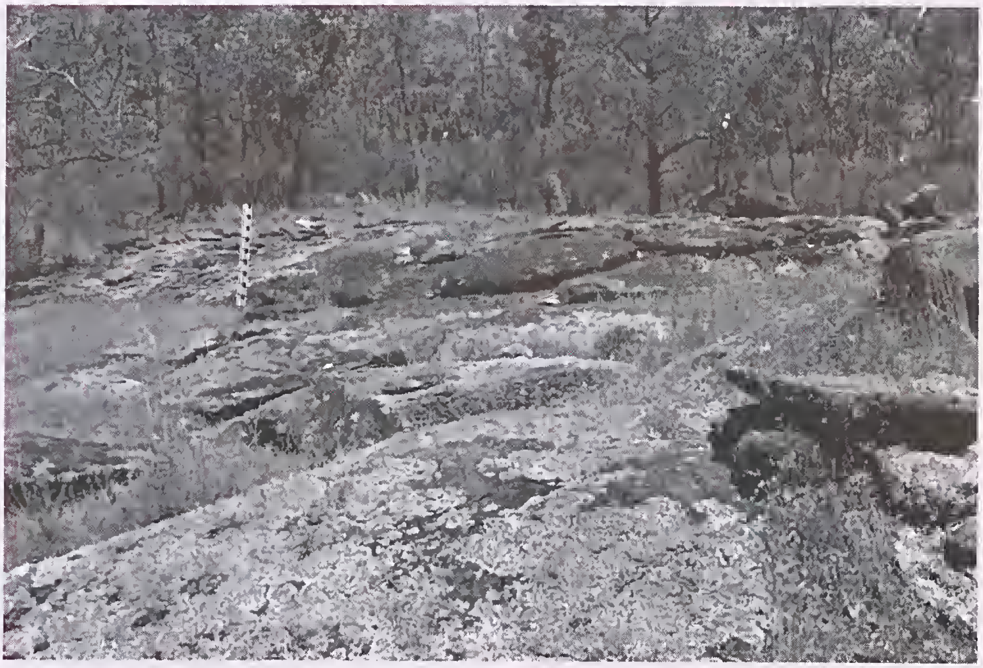

Fig. 11. Community 6a. Small grasslands dominated by *Cymbopogon refractus–Tripogon loliiformis* are found within Attunga State Forest near Tamworth.

Threats and conservation status: This community is not reserved. Grazing by goats is the only major threat.

Community 6b: *Prostanthera nivea–Acacia viscidula* Shrubland (Moonbi Shrublands)

Geology: Moonbi Adamellite.

Trees: *Callitris glaucophylla* (80%), *Eucalyptus prava* (50%), *Eucalyptus dealbata* (20%), *Acacia neriifolia* (80%), *Ficus rubiginosa* (20%), *Brachychiton populneus* (20%).

Shrubs: *Prostanthera nivea* (100%), *Acacia viscidula* (100%), *Zieria cytisoides* (20%), *Hibbertia* sp. 'grandiflora' (40%), *Bertya cunninghamii* (30%), *Olearia elliptica* (40%), *Dodonaea viscosa* (20%), *Desmodium brachypodum* (10%), *Correa reflexa* (10%), *Hovea lanceolata* (10%).

Herbs: *Paspalidium constrictum* (100%), *Cheilanthes sieberi* subsp. *sieberi* (70%), *Gonocarpus teucrioides* (60%), *Commelina cyanea* (90%), *Arthropodium milleflorum* (100%), *Austrodanthonia linkii* (90%), *Tripogon loliiformis* (80%), *Cyperus fulvus* (100%), *Stypandra glauca* (70%), *Microlaena stipoides* (70%).

Restricted taxa: *Hibbertia* sp. 'grandiflora', *Bertya cunninghamii.*

Threats and conservation status: This community is not reserved. The community in the past has been logged for *Callitris*, and at present is disturbed by goats. The community has a relatively high number of exotic species.

Element 7: Western New England Shrublands and Herbfields

This element is widely distributed down the western portion of the Batholith. The communities are dominated by herbaceous species that may occasionally have a scattered shrub overstorey. *Callitris endlicheri, Eucalyptus prava, Eucalyptus dealbata* and other low trees or the mallee, *Eucalyptus quinniorum* m.s. may be present, giving the appearance of low open woodland.

Community 7a: *Cheilanthes sieberi* subsp. *sieberi–Brachycome stuartii* Herbfield (Eagle Creek Herbfields)

Geology: Bolivia Range Leucoadamellite, Mount Mackenzie Adamellite, Mole Granite, (undifferentiated) Leucoadamellite.

Trees: *Callitris endlicheri* (63%), *Eucalyptus prava* (50%), *Eucalyptus dealbata* (19%), *Eucalyptus andrewsii* (25%), *Eucalyptus albens* (6%), *Eucalyptus caleyi* (6%).

Shrubs: *Leucopogon neo-anglicus* (69%), *Plectranthus parviflorus* (56%), *Melichrus urceolatus* (69%), *Prostanthera nivea* (50%), *Calytrix tetragona* (31%), *Acacia macnuttiana* (38%), *Cryptandra amara* var. *floribunda* (25%), *Leptospermum novae-angliae* (19%), *Acacia viscidula* (19%), *Kunzea obovata* (13%).

Herbs: *Brachyscome stuartii* (81%), *Cheilanthes sieberi* subsp. *sieberi* (88%), *Tripogon loliiformis* (88%), *Digitaria breviglumis* (75%), *Gonocarpus teucrioides* (88%), *Fimbristylis dichotoma* (69%), *Aristida jerichoensis* (56%), *Trachymene incisa* (63%), *Entolasia stricta* (75%), *Commelina cyanea* (53%).

Restricted taxa: *Acacia macnuttiana, Callistemon pungens, Acacia pycnostachya, Eriostemon myoporoides* subsp. *epilosus, Brachyloma saxicola, Kunzea bracteolata, Acacia adunca, Zieria odorifera, Mirbelia confertiflora.*

Threats and conservation status: This community is not reserved. Most sites are in private ownership except for Severn State Forest near Ashford in New South Wales. Severn State Forest was logged in 1996. Much of the land around Eagle Creek has been severely degraded, with considerable clearing even on the outcrops. Grazing is intense from sheep and goats at Eagle Creek.

Community 7b: *Leptospermum brevipes–Calytrix tetragona* Shrubland (Balala Shrublands)

Geology: Banalasta Adamellite.

Trees: *Eucalyptus prava* (25%).

Shrubs: *Leptospermum brevipes* (100%), *Calytrix tetragona* (100%), *Acacia viscidula* (100%), *Hovea beckeri* (50%), *Zieria cytisoides* (25%), *Cryptandra amara* subsp. *floribunda* (25%), *Dodonaea viscosa* (25%), *Brachyloma daphnoides* subsp. *glabrum* (25%), *Prostanthera nivea* (75%).

Herbs: *Gonocarpus teucrioides* (100%), *Danthonia monticola* (100%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Crassula sieberiana* (75%), *Stypandra glauca* (50%), *Trachymene incisa* (50%), *Isotoma axillaris* (75%), *Aristida jerichoensis* (25%), *Drosera peltata* (25%), *Cymbopogon refractus* (25%).

Restricted taxa: none recorded.

Threats and conservation status: The community is not reserved. Although protected by the current landholder, changes in ownership may also bring changes in management.

Community 7c: *Gonocarpus teucrioides–Isotoma axillaris* Herbfield (Warrabah Herbfields)

Geology: Gilgai Granite, (undifferentiated) Leucoadamellite.

Trees: *Callitris endlicheri* (83.3%), *Eucalyptus prava* (50%), *Acacia neriifolia* (50%) *Eucalyptus dealbata* (50%), *Acacia falcata* (17%), *Eucalyptus andrewsii* (17%), *Eucalyptus caleyi* (17%).

Shrubs: *Ozothamnus obcordatus* (100%), *Leucopogon muticus* (83%), *Calytrix tetragona* (50%), *Hibbertia linearis* (67%), *Dodonaea viscosa* (100%), *Persoonia cornifolia* (100%), *Homoranthus prolixus* (17%), *Leucopogon melaleucoides* (17%), *Hovea lanceolata* (17%), *Grevillea ramosissima* (17%).

Herbs: *Gonocarpus teucrioides* (83%), *Isotoma axillaris* (83%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Aristida jerichoensis* (50%), *Cymbopogon refractus* (50%), *Cyperus fulvus* (50%), *Lepidosperma laterale* (50%), *Pomax umbellata* (67%), *Stypandra glauca* (67%), *Brachyscome stuartii* (83%).

Restricted taxa: *Homoranthus prolixus, Zieria odorifera, Callistemon pungens.*

Threats and conservation status: This community is not reserved and is threatened by feral goats.

Community 7d: ***Calytrix tetragona–Cryptandra amara*** **subsp.** ***amara*** **Shrubland (Severn Shrublands)** (Fig. 12)

Geology: Undifferentiated.

Trees: *Callitris endlicheri* (50%), *Acacia neriifolia* (75%), *Eucalyptus dealbata* (75%), *Eucalyptus prava* (25%), *Eucalyptus macrorhyncha* (25%).

Shrubs: *Calytrix tetragona* (100%), *Cryptandra amara* subsp. *amara* (75%), *Melichrus urceolatus* (100%), *Beyeria viscosa* (50%), *Leucopogon meleleucoides* (75%), *Leucopogon muticus* (75%), *Leptospermum brevipes* (75%), *Cassinia uncata* (75%), *Ozothamnus obcordatus* (50%), *Olearia elliptica* (50%).

Herbs: *Cheilanthes sieberi* subsp. *sieberi* (100%), *Cyperus fulvus* (100%), *Aristida jerichoensis* (75%), *Wahlenbergia graniticola* (75%), *Cymbopogon refractus* (100%), *Portulaca filifolia* (75%), *Digitaria breviglumis* (75%), *Arthropodium milleflorum* (75%), *Triodia scariosa* (25%), *Crassula sieberiana* (75%).

Restricted taxa: *Hibbertia* sp. B, *Acacia macnuttiana*, *Olearia gravis*.

Threats and conservation status: This community is not reserved. Threats to the community are mainly from goats and possible changes in management strategies.

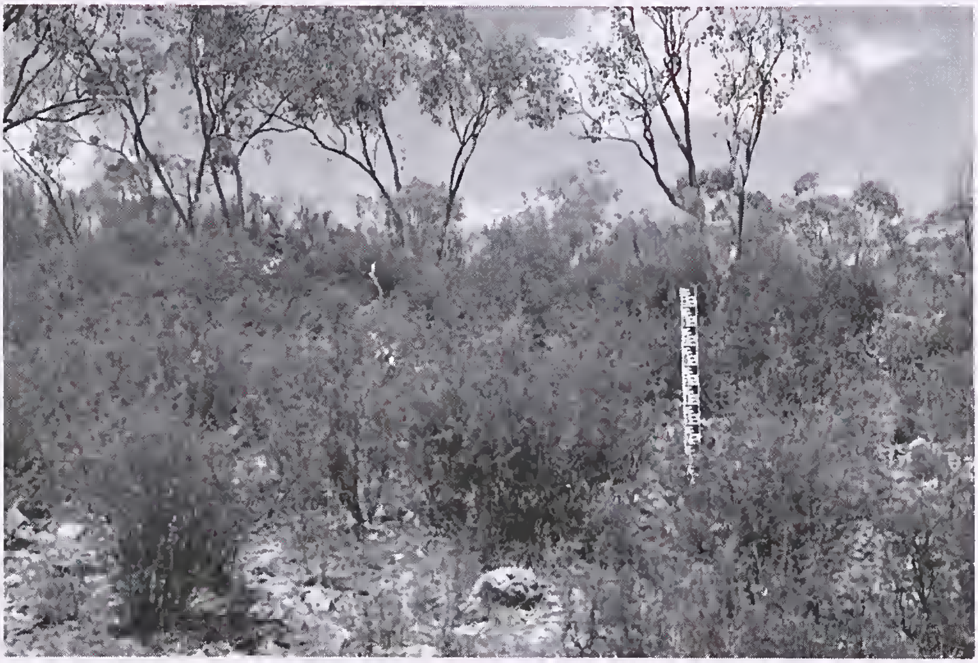

Fig. 12. Community 7d. *Calytrix tetragona–Cryptandra amara* dominated shrublands occur occasionally near 'the Barbs' near Pindari Dam on the Severn River.

Community 7e: *Calytrix tetragona–Kunzea obovata* Shrubland (Parlour Mountain Shrublands)

Geology: Parlour Mountain Leucoadamellite.

Trees: *Eucalyptus prava* (89%), *Eucalyptus youmanii* (22%), *Eucalyptus dealbata* (11%).

Shrubs: *Leucopogon neo-anglicus* (100%), *Calytrix tetragona* (100%), *Kunzea obovata* (100%), *Hibbertia riparia* (44%), *Acacia triptera* (44%), *Hibbertia* sp. aff. *monogyna* (56%), *Leucopogon melaleucoides* (78%), *Boronia anethifolia* (44%), *Persoonia cornifolia* (67%), *Prostanthera nivea* (33%).

Herbs: *Austrodanthonia linkii* (100%), *Lepidosperma laterale* (89%), *Digitaria breviglumis* (100%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Entolasia stricta* (89%), *Gonocarpus teucrioides* (89%), *Trachymene incisa* (89%), *Aristida jerichoensis* (89%), *Paspalidium constrictum* (56%), *Lobelia gracilis* (78%).

Restricted taxa: *Hibbertia* sp. aff. *monogyna*, *Mirbelia confertiflora*, *Eucalyptus youmanii*, *Acacia granitica*, *Boronia granitica*.

Threats and conservation status: This community is not reserved. Selective logging has occurred over much of the area and cattle and sheep graze most properties. Furthermore, feral goats and cattle threaten some outcrops.

Community 7f: *Calytrix tetragona–Ozothamnus obcordatus* Shrubland (Ironbark Shrublands)

Geology: (Undifferentiated) Leucoadamellite.

Trees: *Callitris endlicheri* (73%), *Eucalyptus prava* (47%), *Acacia neriifolia* (33%), *Eucalyptus dealbata* (20%), *Eucalyptus quinniorum* m.s. (20%), *Eucalyptus caleyi* (7%), *Eucalyptus macrorhyncha* (7%).

Shrubs: *Calytrix tetragona* (80%), *Leucopogon neo-anglicus* (40%), *Ozothamnus obcordatus* (53%), *Leptospermum novae-angliae* (40%), *Leucopogon muticus* (67%), *Leptospermum brevipes* (33%), *Cryptandra amara* var. *floribunda* (33%), *Homoranthus bornhardtiensis* m.s. (27%), *Prostanthera nivea* (47%), *Boronia anethifolia* (27%).

Herbs: *Cheilanthes sieberi* subsp. *sieberi* (100%), *Gonocarpus tetragynus* (93%), *Trachymene incisa* (73%), *Austrodanthonia monticola* (80%), *Tripogon loliiformis* (67%), *Isotoma anethifolia* (73%), *Isolepis hookeriana* (53%), *Brachyscome stuartii* (33%), *Stypandra glauca* (47%), *Hydrocotyle peduncularis* (40%).

Restricted taxa: *Homoranthus bornhardtiensis* m.s., *Eucalyptus quinniorum* m.s., *Cypanthera albicans* subsp. *albicans*, *Callistemon pungens*.

Threats and conservation status: This community is reserved in Ironbark Nature Reserve. Feral goats and rabbits are in all areas and are the only threat.

Community 7g: *Cheilanthes sieberi* subsp. *sieberi–Arthropodium milleflorum* Herbfield (Flaggy Range Herbfields) (Fig. 13)

Geology: Tilmunda Adamellite, Banalasta Adamellite, (undifferentiated) Leucoadamellite, Yarrowyck Granodiorite.

Trees: *Callitris endlicheri* (66%), *Acacia neriifolia* (56%), *Eucalyptus prava* (48%), *Eucalyptus dealbata* (30%), *Callitris glaucophylla* (7%), *Acacia leiocalyx* (18%), *Angophora floribunda* (16%), *Ficus rubiginosa* (14%), *Casuarina cunninghamiana* (2%), *Brachychiton populneus* (7%), *Eucalyptus quinniorum* m.s. (7%).

Shrubs: *Leptospermum brevipes* (30%), *Calytrix tetragona* (30%), *Prostanthera nivea* (32%), *Cryptandra amara* var. *floribunda* (43%), *Cassinia quinquefaria* (34%), *Acacia viscidula* (30%), *Leucopogon muticus* (30%), *Ozothamnus obcordatus* (18%), *Homoranthus prolixus* (7%), *Melichrus urceolatus* (35%).

Herbs: *Cheilanthes sieberi* subsp. *sieberi* (100%), *Tripogon loliiformis* (93%), *Arthropodium milleflorum* (91%), *Crassula sieberiana* (86%), *Aristida jerichoensis* (86%), *Digitaria breviglumis* (77%), *Calandrinia eremaea* (75%), *Cymbopogon refractus* (64%), *Cyperus fulvus* (57%), *Gonocarpus teucrioides* (43%).

Restricted taxa: *Homoranthus prolixus*, *Acacia granitica*, *Kunzea bracteolata*, *Eucalyptus quinniorum* m.s., *Eucalyptus youmanii*, *Acacia williamsiana*.

Threats and conservation status: This community is subject to intense grazing from domestic and feral animals especially goats. Examples of this community are reserved within Warrabah National Park and Mount Yarrowyck Nature Reserve.

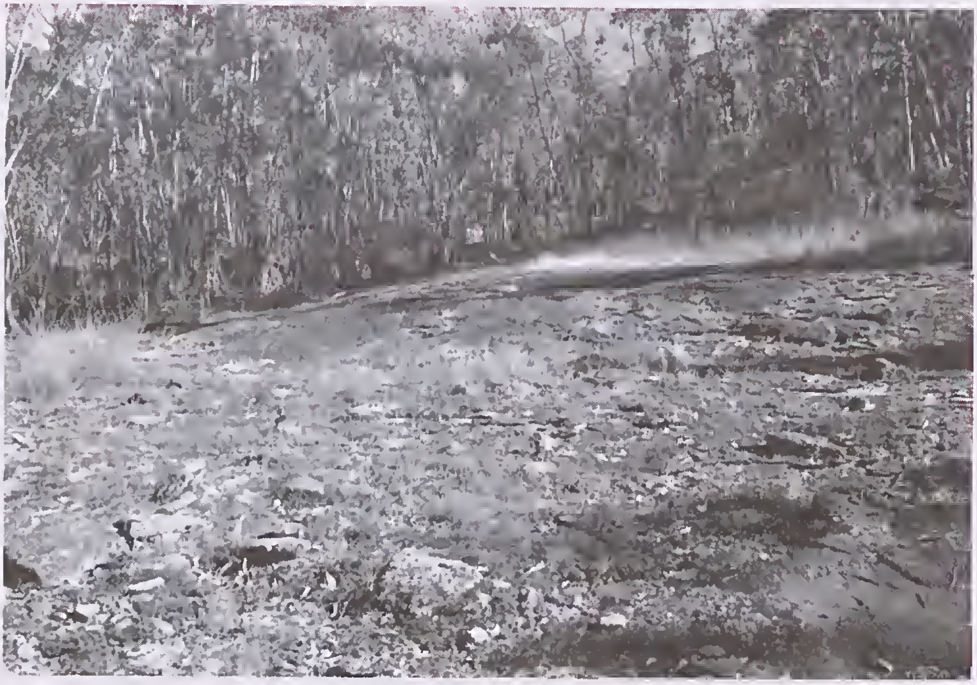

Fig. 13. Community 7g. Herbfields dominated by *Cheilanthes sieberi* subsp. *sieberi*–*Arthropodium milleflorum* are common along the western side of the New England Batholith from Eagle Creek to the Flaggy Range.

Community 7h: *Cheilanthes sieberi* subsp. *sieberi–Isotoma axillaris* Herbfield (Flaggy Range Herbfields)

Geology: Tilmunda Adamellite, Banalasta Adamellite.

Trees: *Acacia neriifolia* (83%), *Callitris endlicheri* (33%), *Eucalyptus prava* (50%), *Eucalyptus quinniorum* m.s. (50%), *Eucalyptus youmanii* (50%).

Shrubs: *Ozothamnus obcordatus* (33%), *Cassinia quinquefaria* (17%), *Olearia viscidula* (50%), *Persoonia cornifolia* (50%), *Cryptandra amara* var. *floribunda* (33%), *Leptospermum novae-angliae* (33%), *Melichrus urceolatus* (17%), *Acacia ulicifolia* (17%), *Calytrix tetragona* (17%), *Cassinia uncata* (17%), *Correa reflexa* (17%), *Leptospermum brevipes* (17%).

Herbs: *Cheilanthes sieberi* subsp. *sieberi* (83%), *Isotoma axillaris* (67%), *Urtica incisa* (50%), *Crassula sieberiana* (50%), *Austrodanthonia monticola* (100%), *Aristida jerichoensis* (33%), *Lobelia gracilis* (67%), *Calandrinia eremaea* (50%), *Lepidosperma laterale* (83%), *Einadia hastata* (33%).

Restricted taxa: *Eucalyptus quinniorum* m.s., *Eucalyptus youmanii.*

Threats and conservation status: This community is not reserved. Goats are the major threat to this community.

Element 8: Kwiambal Grasslands

This community is restricted to the area surrounding the junction of the Severn and Macintyre Rivers and is dominated by grasses and other herbaceous taxa. Sparsely distributed shrub species may occasionally occur such as *Melichrus urceolatus* or *Acacia williamsiana* giving the appearance of low open shrubland. *Callitris endlicheri, Callitris glyciphylla* or eucalypts such as *Eucalyptus dealbata* or *Eucalyptus prava* amongst others give an overall appearance of low open woodland.

Community 8a: *Aristida vagans–Tripogon loliiformis* Grassland (Kwiambal Grasslands) (Fig. 14)

Geology: (undifferentiated) Granite.

Trees: *Eucalyptus dealbata* (82%), *Callitris glaucophylla* (77%), *Acacia leiocalyx* (46%), *Callitris endlicheri* (27%), *Ficus rubiginosa* (27%), *Corymbia dolichocarpa* (18%), *Casuarina cunninghamiana* (9%).

Shrubs: *Melichrus urceolatus* (91%), *Plectranthus parviflorus* (82%), *Leptospermum brevipes* (64%), *Acacia williamsiana* (46%), *Astrotricha roddii* (36%), *Olearia ramosissima* (36%), *Prostanthera saxicola* (36%), *Hovea lanceolata* (18%), *Mirbelia pungens* (18%), *Phyllanthus carpentariae* (27%).

Herbs: *Aristida vagans* (100%), *Tripogon loliiformis* (90%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Commelina cyanea* (100%), *Crassula sieberiana* (82%), *Aristida ramosa* (73%), *Gonocarpus tetragynus* (73%), *Aristida jerichoensis* (46%), *Bulbostylis barbata* (24%), *Stylidium laricifolium* (55%).

Restricted taxa: *Acacia williamsiana, Astrotricha roddii, Olearia gravis.*

Threats and conservation status: The community is often disturbed and is threatened primarily from feral animals, particularly goats. Some localities within Severn River State Forest are being logged. Some areas are within the proposed Kwiambal National Park, however most are not within present park boundaries. The boundaries of the National Park are not fixed at this stage and further inclusions may add to the reservation status of this community.

Element 9: Howell Shrubland

These communities occur primarily around Copeton Dam and Goonoowigal near Inverell with a minor occurrence at Warrabah. Low shrubs, particularly *Homoranthus prolixus* and *Babingtonia densifolia* dominate. Occasionally all shrubs may be absent giving a grassland structure, or *Callitris endlicheri* and various eucalypts such as *Eucalyptus dealbata* and *Eucalyptus prava* may be present giving the appearance of a low open woodland.

Community 9a: *Babingtonia densifolia–Homoranthus prolixus* Shrubland (Howell Shrublands)

Geology: Gilgai Granite, (undifferentiated) Leucoadamellite.

Trees: *Callitris endlicheri* (88%), *Eucalyptus dealbata* (52%), *Eucalyptus prava* (24%), *Acacia neriifolia* (21%).

Shrubs: *Babingtonia densifolia* (91%), *Homoranthus prolixus* (85%), *Leucopogon neo-anglicus* (76%), *Acacia triptera* (58%), *Micromyrtus sessilis* (33%), *Leucopogon melaleucoides* (64%), *Ozothamnus obcordatus* (36%), *Prostanthera nivea* (39%), *Acacia granitica* (52%), *Eriostemon myoporoides* subsp. *conduplicatus* (36%).

Herbs: *Paspalidium constrictum* (97%), *Lepidosperma laterale* (97%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Tripogon loliiformis* (91%), *Gonocarpus tetragynus* (79%), *Brachyscome stuartii* (76%), *Aristida jerichoensis* (82%), *Trachymene incisa* (67%), *Lobelia gracilis* (79%), *Fimbristylis dichotoma* (61%).

Restricted taxa: *Homoranthus prolixus, Acacia granitica, Zieria odorifera, Dodonaea stenophylla, Hibbertia kaputarensis, Boronia granitica, Phebalium rotundifolium.*

Threats and conservation status: This community is probably not reserved. However as this is the most common community in the Howell area it is possible that this community may occur on the western side of Copeton Dam where small outcrops occur in the Copeton State Recreation Area. Feral goats are abundant and are a threat to this community.

Community 9b: *Homoranthus prolixus* Shrubland (Howell Shrublands) (Fig. 15)

Geology: Tingha Granite.

Trees: *Acacia neriifolia* (33%), *Eucalyptus dealbata* (17%), *Eucalyptus prava* (17%), *Callitris endlicheri* (17%).

Shrubs: *Homoranthus prolixus* (100%), *Leucopogon neo-anglicus* (68%), *Acacia triptera* (83%), *Babingtonia densifolia* (68%), *Cryptandra amara* subsp. *floribunda* (17%),

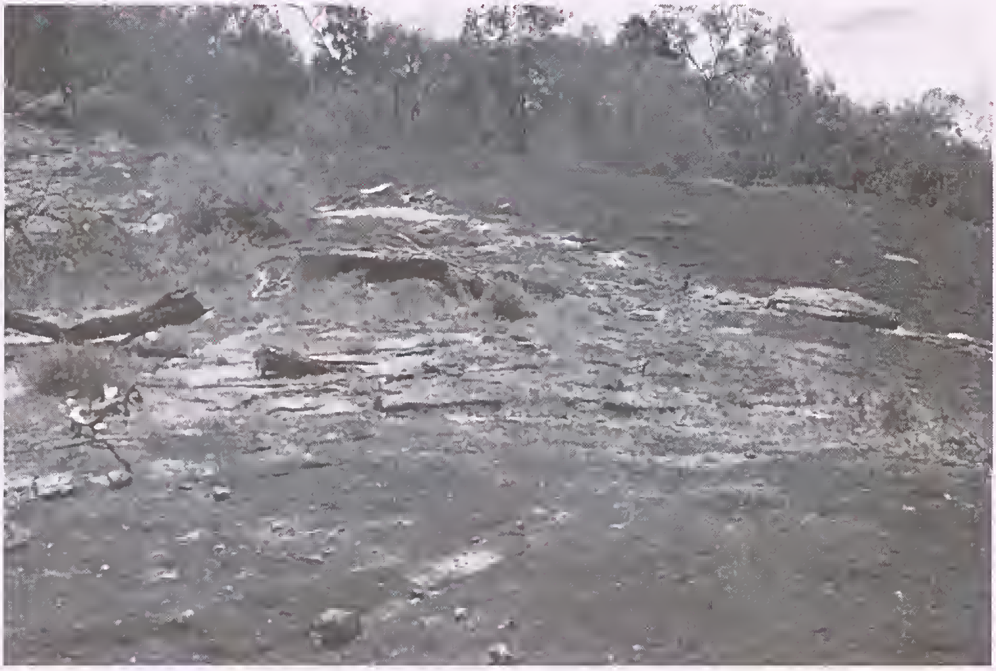

Fig. 14. Community 8a. Severn State Forest and the Kwiambal National Park have *Aristida vagans–Tripogon loliiformis* dominating outcrops.

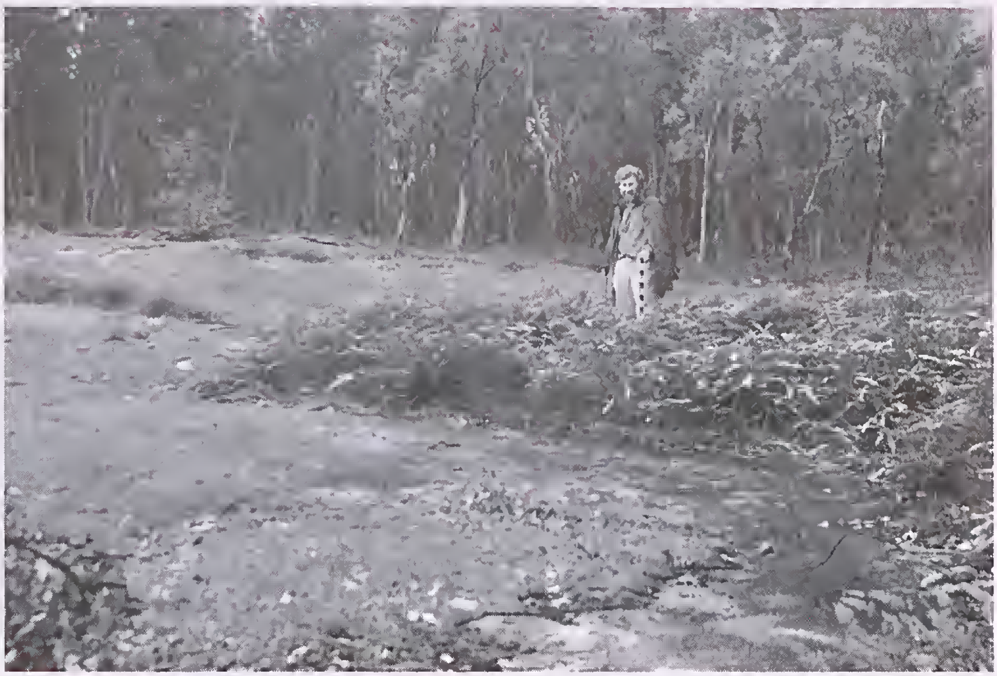

Fig. 15. Community 9b. *Homoranthus prolixus* is a very noticeable dominant on the outcrops in the Howell and Copeton Dam areas.

Leucopogon melaleucoides (17%), *Eriostemon myoporoides* subsp. *conduplicatus* (17%), *Olearia elliptica* (17%), *Persoonia cornifolia* (17%), *Prostanthera nivea* (83%).

Herbs: *Paspalidium constrictum* (100%), *Cheilanthes sieberi* subsp. *sieberi* (100%), *Commelina cyanea* (100%), *Lepidosperma laterale* (100%), *Brachyscome stuartii* (100%), *Portulaca filifolia* (83%), *Einadia hastata* (100%), *Tripogon loliiformis* (100%), *Portulaca oleracea* (83%), *Oxalis chnoodes* (100%).

Restricted taxa: *Homoranthus prolixus*, *Zieria odorifera*.

Threats and conservation status: This community is not reserved. Feral goats are the major threat.

Closed Shrub

The community was not quantitatively surveyed because of its very restricted occurrence and difficulties of access. It has been included here for completeness. This community is restricted to deep crevices, clefts and sheltered areas on large granitic outcrops or between large boulders (Fig. 16).

Community 10: *Quintinia sieberi–Rapanea* spp. Closed Shrub (Eastern New England Closed Scrub)

Geology: Oban River Leucoadamellite, Round Mountain Leucoadamellite, Stanthorpe Adamellite.

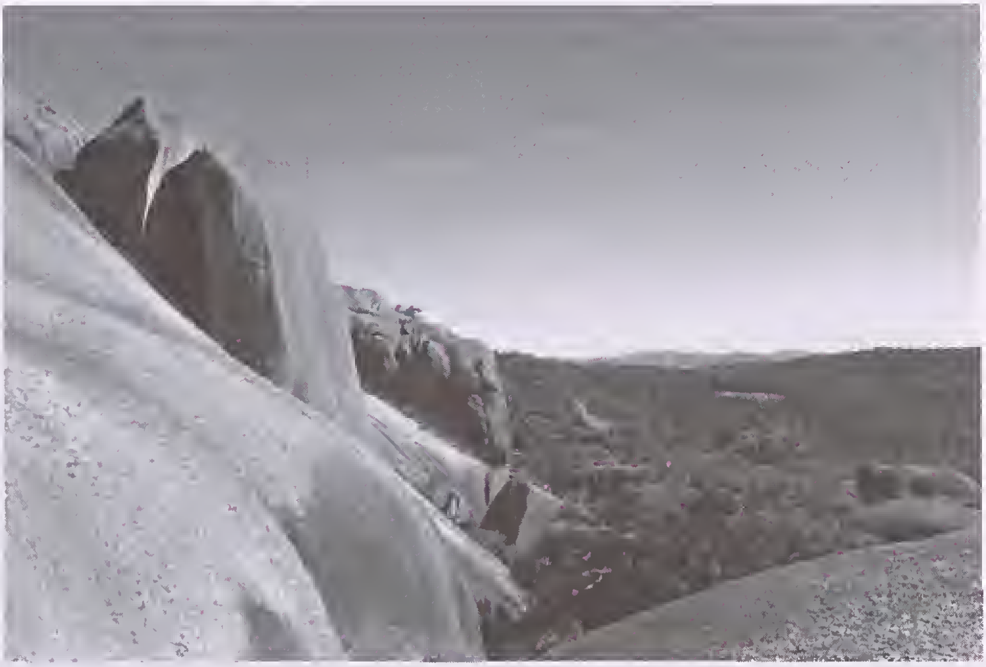

Fig. 16. Community 10. This community is very restricted and occurs usually between the crevices of very large outcrops. South Bald Rock (shown here) has two large crevices that contain *Quintinia sieberi–Rapanea* spp. closed scrub (not visible here).

Common taxa: *Quintinia sieberi, Rapanea* spp., *Notelaea* sp. A., *Leptospermum polygalifolium* subsp. *montanum, Tasmannia glaucophylla, Cyathea australis, Trochocarpa laurina.*

Threats and conservation status: All known occurrences are within some form of reservation. The community has been observed along the eastern escarpment of the batholith at Crown Mountain Flora Reserve, Girraween National Park, and Cathedral Rock National Park. Due to inaccessibility this community is little disturbed and not considered to be under threat.

Discussion

Comparison with previous investigations

Almost all the previous survey work on the outcrop flora of the New England Batholith deals with the areas included within elements one to three. The vegetation on the western side of the Batholith has been only described by Bowlay (1992), Clarke et al. (1995), Le Brocque and Benson (1995), Clarke et al. (1998) and Hunter (1998c).

Specht et al. (1974) describe four alliances for New South Wales of some relevance to the granitic outcrops of the New England Batholith. Problems in defining alliances based on structure are apparent. Some alliances are defined many times, for example the New England outcrop community *Leptospermum* spp.–*Allocasuarina rigida*, is defined at least three times as: tall montane shrubland, closed montane heath, and open montane heath. Furthermore, *Eucalyptus codonocarpa* is considered to be distinct from the heath alliances on the New England Tablelands. Although Specht et al. (1995) have provided a more quantitative analysis in the definition of communities, they again define the *Eucalyptus codonocarpa* community as separate from the floristically similar but structurally different adjacent heath communities, defined by these authors as *Allocasuarina rigida–Leptospermum* spp.–*Kunzea bracteolata*. This is surprising as Specht et al. is based on floristic analysis. Both our results and those of Benson & Ashby (1996) suggest that the heath communities on granitic outcrops and the *Eucalyptus codonocarpa* communities are floristically similar. Specht et al. (1995) and New South Wales National Parks & Wildlife Service (1995) define a *Eucalyptus scoparia* community as distinct from the heath communities. We have found that *Eucalyptus scoparia* is an infrequent species of heaths within the Girraween and Bald Rock areas and does not affect overall floristic distinction when it occurs. Individual communities described on floristic grounds may have a range of structures.

Specht et al. (1974) define three heath/shrubland alliances for New South Wales that are of relevance to our study, namely *Calytrix tetragona, Epacris brevifolia* and *Leptospermum novae-angliae–Allocasuarina rigida*. As only a few frequent taxa are given it is difficult to establish the similarity of their communities to those we have defined. However, based on the dominant species they list, the *Calytrix tetragona* alliance may approximate the communities defined in our element four. Those of the latter two alliances may somewhat approximate elements one and two, with some notable differences. The *Epacris brevifolia* group as defined by Specht et al. (1974) includes dominant taxa that are found primarily on outcrops, together with those from wet

Table 2: Selected attributes of each of the 28 communities defined by analysis and one additional recognised community.

Community Number	Number of Samples	Dominant Taxa	Common Structural Type	Locality	No. of Taxa	Mean Taxa Per Sample	No. of Exotic Taxa
1a	16	*Leptospermum novae-angliae–Kunzea obovata*	Heathland	BC	126	40	3
1b	14	*Kunzea obovata*	Heathland	BC BL	104	30	3
1c	22	*Leptospermum novae-angliae*	Heathland	BC	117	32	3
2a	5	*Leptospermum novae-angliae–Brachyloma saxicola*	Heathland	BL CH GR DM	133	44	NA
2b	4	*Acacia viscidula–Kunzea opposita*	Heathland	JB	67	39	1
2c	3	*Leptospermum novae-angliae–Leucopogon cicatricatus*	Heathland	CR	47	24	1
2d	31	*Leptospermum novae-angliae–Acacia latisepala*	Heathland	BR DM JB	202	29	7
2e	7	*Leptospermum novae-angliae–Dodonaea viscosa*	Heathland	BR	107	29	4
2f	21	*Kunzea bracteolata–Leucopogon melaleucoides*	Heathland	BR	103	19	5
3a	23	*Kunzea bracteolata–Leptospermum novae-angliae*	Heathland	GR	147	36	3
4a	14	*Leucopogon neo-anglicus–Micromyrtus sessilis*	Shrubland	BH CH GR	99	28	1
4b	38	*Prostanthera staurophylla–Kunzea bracteolata*	Shrubland	TT	169	33	2
4c	2	*Babingtonia odontocalyx–Brachyloma saxicola*	Shrubland	TT	42	27	1
5a	23	*Calytrix tetragona–Leptospermum novae-angliae*	Shrubland	KP SR WW	134	33	1
5b	11	*Allocasuarina brachystachya*	Shrubland	SR	98	44	NA

Community Number	Number of Samples	Dominant Taxa	Common Structural Type	Locality	No. of Taxa	Mean Taxa Per Sample	No. of Exotic Taxa
6a	2	*Cymbopogon refractus–Tripogon loliiformis*	Grassland	AT	67	48	10
6b	10	*Prostanthera nivea–Acacia viscidula*	Shrubland	MB	98	32	12
7a	12	*Cheilanthes sieberi–Brachycome stuartii*	Herbfield	BH EC KP TT WB	150	33	3
7b	4	*Leptospermum brevipes–Calytrix tetragona*	Shrubland	ML	36	36	2
7c	6	*Gonocarpus teucrioides–Isotoma axillaris*	Herbfield	HC WB	85	29	1
7d	4	*Calytrix tetragona–Cryptandra amara subsp. amara*	Shrubland	SR	86	37	4
7e	9	*Calytrix tetragona–Kunzea obovata*	Shrubland	PM	100	36	2
7f	15	*Calytrix tetragona–Ozothamnus obcordatus*	Shrubland	IB	117	28	2
7g	44	*Cheilanthes sieberi–Arthropodium milleflorum*	Herbfield	FR ML SR WB YH	212	31	15
7h	6	*Cheilanthes sieberi–Isotoma axillaris*	Herbfield	FR ML	56	20	5
8a	11	*Aristida vagans–Tripogon loliiformis*	Grassland	KL	101	34	7
9a	33	*Babingtonia densifolia–Homoranthus prolixus*	Shrubland	HC WB	111	29	6
9b	6	*Homoranthus prolixus*	Shrubland	HC	81	43	10
10	-	*Quintinia sieberi–Rapanea* spp.	Closed Scrub	BC BR CR	-	-	-

heaths in the region. For example, this alliance is defined as containing *Hakea microcarpa* and *Epacris brevifolia* which are restricted to areas of poor drainage, and *Cryptandra lanosiflora* and *Leucopogon neo-anglicus* which are granitic outcrop endemics. These combinations of species cannot be reconciled with our data.

Specht et al. (1995) define a heath community *Allocasuarina rigida–Leptospermum* spp.–*Kunzea bracteolata*, equivalent to elements one to three. The species *Allocasuarina rigida* was also used to define communities on the New England Batholith by Specht et al. (1974), and the New South Wales National Parks and Wildlife Service (1995). In our survey *Allocasuarina rigida* is neither frequent nor abundant, and its use as a defining species by Specht et al. (1995) in their quantitatively defined communities is anomalous. This species may certainly become dominant in areas around the Mount Warning Shield (e.g. Lamington National Park) but is infrequent in most outcrops on the New England Batholith. *Leptospermum novae-angliae* is probably the best defining species for granitic outcrop areas, particularly those within elements one to three.

The New South Wales National Parks and Wildlife Service (1995) in their survey of the upper north-east of New South Wales identified several associations of relevance to granitic outcrops that we have included within elements two and three. The associations they define are: *Kunzea bracteolata–Allocasuarina littoralis, Kunzea bracteolata–Boronia bipinnata, Kunzea bracteolata–Grevillea acerata, Kunzea bracteolata–Leptospermum novae-angliae* and *Leptospermum novae-angliae–Leptospermum variabile*. Most of these associations are narrowly defined and the first and last would fall within Community 2a, while the other three would fall within Community 3a.

Binns (1992, 1995) describes communities that occur on granite outcrops on the New England Batholith and are similar to those defined in element two. Benson & Ashby (1996) defined a community found on granitic outcrops of the Guyra area. This community was variable in structure and termed 'Mallee (*Eucalyptus codonocarpa*) and Heath on Rocky Outcrops on Leucogranite'. This community corresponds directly to Community 1c, 'Backwater Heaths'.

Bowlay (1992), Clarke et al. (1995) and Le Brocque and Benson (1995) surveyed areas and defined communities within the north-western portion of the New England Batholith. Le Brocque and Benson (1995) included our Community 5b within a broader *Eucalyptus caleyi/Allocasuarina inophloia* association. Clarke et al. (1995) defined two rocky outcrop communities, *Eucalyptus prava* and *Eucalyptus dealbata–Eucalyptus caleyi–Callitris endlicheri*, which are defined on the species in the upper stratum. These two communities being based on the same data are synonymous with Community 5a *Leucopogon neo-anglicus–Calytrix tetragona* Low Shrubland. Similarly using some of the same data Clarke et al. (1998) define a *Eucalytpus prava–Callitris endlicheri–Eucalyptus andrewsii* community that is synomymous with Community 4b and *Eucalytpus prava–Eucalyptus dealbata–Callitris endlicheri* community that is synonymous with Community 7a.

Classifying Outcrop Communities

Communities found on granitic outcrops have a high proportion of restricted taxa which make them distinct from the surrounding forest vegetation. This fact has been noted elsewhere in Australia (Aston & Webb 1977; George et al. 1979; Beadle 1981; Benwell 1995) and within the region under investigation (Binns 1995). The communities are often visually variable from one patch to another within the same area in both structure and dominant taxa. Overall, floristic similarity may vary little between these patches yet traditionally they have been given different names often based simply on structure. Each community is derived from a limited source pool. However, the populations found within patches of vegetation on outcrops are comparatively small and isolated and prone to changes in dominant taxa based on an increase in the probability of extinction and chance colonisation and establishment. This has caused problems in the description of rocky outcrop communities.

Binns (1992, 1995) found problems in using traditional methods based on consistent structure and consistent dominant taxa for outcrop communities on the New England Batholith. Binns stated that composition appeared to be highly variable both within and between patches, with no obvious pattern, and that composition may depend on chance colonisation. Hambler (1964) who qualitatively described granite outcrop communities in western Nigeria using a structural system also noted such problems. He wrote: 'All observable communities cannot be fitted into this classification since a multiplicity of different habitats often occurs in a small area giving a mosaic community. Where a community can be typified by the occurrence of a dominant species the supporting flora may vary from place to place owing partly to variations in the age and condition of the dominant species, and perhaps partly to barriers to dissemination between the island hills'.

Many of these problems relate to the scale of sampling. Binns (1992, 1995) sampled only a small number of outcrops over a large area and did not see the consistency that is apparent in a more intensive investigation. Similarly, Hambler (1964) concentrating on a few outcrops within the same area was unable to see any consistency at the detailed scale of his survey. We have found that communities will be consistent in their overall shared taxa within each defined community regardless of the presence or absence of specific taxa in the uppermost stratum or visual differences in structure. Benson & Ashby (1996) also noted that the dominant species in the upper stratum of one patch may or may not be present in an adjacent patch (e.g. *Eucalyptus codonocarpa*) yet the similarity in overall floristics was high.

Representation in conservation reserves

Conservation often follows the ad hoc reservation of areas with the least potential for commercial land use (Pressey & Tully 1994). Granitic outcrop areas generally have a low potential for commercial land use. The more inaccessible granitic outcrop areas are the most highly represented in the reserve system while those more accessible are the least conserved. Element two occurs in six National Parks (Table 3), and all of the communities within this group are within at least one National Park. No communities of elements six and nine are in any form of reservation. Element seven has eight communities within it with five communities not reserved. Reservation priorities for granitic outcrop communities are suggested and the following priority list for the New England Batholith is presented:

Element not reserved:

Element 6: Communities 6a & 6b.

Element 9: Communities 9a & 9b.

Element under-represented in the reserve network:

Element 7: Communities 7b, 7c, 7d, 7e & 7h not reserved.

Element 2: Community 2b not reserved.

Element conserved well — all communities conserved, none within the National Park or Nature Reserve network:

Element 1: Communities 1a, 1b & 1c.

Element 4: Communities 4b & 4c.

Overall, granitic outcrop communities are generally less disturbed than other habitats. However, feral goats are a considerable problem in almost all the regions investigated particularly those in the western portion of the region.

Table 3: Summary of the current types of conservation reserves known to include the nine major vegetation elements. Private Reserve includes areas under conservation agreements with National Parks and Wildlife Service.

Element Number	Private Reserve	Designated State Forest Preserve	Nature Reserve	State Recreation Area	National Park
1	1	2	-	-	-
2	-	1	1	-	6
3	-	-	-	-	1
4	-	-	-	1	-
5	-	-	1	-	1
6	-	-	-	-	-
7	-	-	3	1	2
8	-	-	-	-	1
9	-	-	-	-	-

Conclusion

The communities found on granitic outcrops on the New England Batholith are diverse and widespread and are significant in terms of the high number of rare and restricted taxa. These communities are overlooked during most floristic surveys and in particular the areas to the west of the New England Tablelands. These communities in the past have been inadequately defined. The use of structure alone does not result in ecologically realistic community definitions and is misleading. The stochastic nature of the distribution of taxa common to a single community can change its structural appearance without affecting the overall floristic similarity. Granitic outcrops retain remnants of native vegetation in modified rural landscapes. These communities are often not well represented within conservation reserves especially in the western parts of the tablelands. This situation needs to be addressed through appropriate regional conservation planning that ensures a comprehensive and representative reserve system.

Acknowledgments

J. Bruhl is thanked for partial supervision of this project. The Centre for Resource and Environmental Studies, Australian National University, kindly supplied climate data. The following people aided in field work P. Williams, V. Hunter, J. Bruhl, P. Richards and E. Fallovollita. M. Henderson processed many voucher specimens. The following property owners are thanked for allowing access to their land B & J. Humphries, B. & E. McCowen, P. & D. Morton, T. Hollingsworth, J. Finnerty, A. & J. Harvey, A. Watt, J. & A. Sands, R. & M. Wade, A. Dew, R. & B. Rummery, N. & D. Webber, R. Beardsell, T. Rummery, B. Heash, R. Taylor, D. & N. McBean, P. & P. Cairns, G. McIntosh, W. Hadkins, P. & W. Gore, T. & V. Hellmann and the many others who allowed access on specific occasions. Thanks also to the directors of the New South Wales and Queensland National Parks and Wildlife Services for permission to collect and survey in service areas; the staff of the Glen Innes district office of the National Parks and Wildlife Service; the local staff of Girraween National Park; the director of the State Forests of New South Wales for permission to collect and survey in state forests; the former board of trustees for the Torrington Regional Reserve; J. Williams, G. Roberts and S. Hopper for discussions on granitic outcrops; Dr B. Briggs for allowing access to specimens and facilities at The National Herbarium of NSW. D. Bell, R. Tremont, P. Richards and an anonymous referee made constructive comments on the manuscript. JTH acknowledges the receipt of an Australian Postgraduate Award.

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Manuscript Accepted 25 May 1998

Appendix 1.

Published Nationally Rare or Threatened Australian Plants

A large number of nationally rare or threatened Australian plants (ROTAP) (Briggs & Leigh 1996) have been recorded in this survey growing on granitic outcrops.

Acacia adunca (Family Fabaceae) (3RC-) occurs mainly in the Girraween, Bald Rock and Boonoo Boonoo National Parks but also at Bolivia Hill north of Glen Innes. At Bolivia Hill the population is large and occurs mainly in the intervening zone between forest and outcrops. At Bald Rock and Girraween National Parks this species was seen to germinate in profusion after severe fires at altitudes under 1100 m on and around outcrops.

Acacia barringtonensis (Family Fabaceae) (3RCa) occurs mainly in the Barrington Tops area of southern portion of the New England Tablelands in New South Wales, this species is also known from the Backwater and Gibraltar Range areas. Small populations of this species were found in Gibraltar Range National Park.

Acacia betchei (Family Fabaceae) (2RC) occurs in the Torrington area of New South Wales. Populations of this species were found in the Torrington area where the species was abundant in forests and on outcrops especially in areas that had recently been burnt.

Acacia brunioides subsp. *brunioides* (Family Fabaceae) (3RC-) is known from the Gibraltar Range and Backwater (Crown Mountain) in north-eastern New South Wales. This taxon was found in isolated but extensive populations in Gibraltar Range National Park.

Acacia granitica (Family Fabaceae) (3RC-) occurs in the north-east of New South Wales and Southern Queensland. Populations of this species have previously been recorded from localities on the North Coast of New South Wales, but also at Torrington, Howell, Girraween National Park and Crown Mountain within the survey area. Populations of this species were found at Girraween National Park, Torrington, Howell, and the Flaggy Range near Bendemeer.

Acacia latisepala (Family Fabaceae) (3RC-) is known to occur in the Girraween and Bald Rock National Parks and at Torrington. This species was seen in great abundance

(Hunter 1995) in Bald Rock and Girraween National Parks and Torrington in areas recently burnt by fires.

Acacia macnutiana (Family Fabaceae) (2VC-) is known from Boonoo Boonoo Falls, Torrington and Pindari Dam (Bowlay 1992) in northern New South Wales. Populations of this species were found at Torrington, Eagle Creek and Pindari Dam on the Severn River.

Acacia pycnostachya (Family Fabaceae) (2V) is known from disjunct localities in northern New South Wales, primarily from Bolivia Hill and Bluff Rock south of Tenterfield. Large populations were found at Bolivia Hill where it dominates many areas on the rock outcrops and margins.

Acacia williamsiana (Family Fabaceae) (2RCa) was found at Kings Plains and Kwiambal National Parks, Severn River Nature Reserve and Torrington. This species is restricted to rocky outcrops and is locally common where it is found.

Acacia torringtonensis (Family Fabaceae) (3RC) is known from Torrington and Kings Plains National Park. This species was found at Torrington, Kings Plains National Park, Severn River Nature Reserve, the Barbs at Pindari Dam and on private property in the Willows area.

Allocasuarina brachystachya (Family Casuarinaceae) (2RCa) is known from localities near Moredun Dam, Emmaville and Kings Plains National Park. This species was found in large numbers at Kings Plains National Park, Severn River Nature Reserve and private properties in the Willows area.

Allocasuarina rupicola (Family Casuarinaceae) (2RC-) is known from Girraween and Boonoo Boonoo National Parks in southern Queensland and northern New South Wales. This species was found at various localities within Girraween National Park.

Astrotricha roddii (Family Araliaceae) (3VCa) is known from Kings Plains National Park, Kwiambal National Park, Severn River Nature Reserve and the Barbs near Pindari Dam in New South Wales and Mount Bullagang in Queensland (Nadolny et al. 1997). Populations of this species were found at Kings Plains and Kwiambal National Park, Severn River Nature Reserve, the Barbs near Pindari Dam, Severn State Forest, and on private property near the Willows.

Bertya glandulosa (Family Euphorbiaceae) (2KC-) occurs in the granite belt in Queensland. This species was recorded from the margins of a granitic outcrop in Girraween National Park.

Boronia granitica (Family Rutaceae) (3VC-) is found in the granite belt of Queensland around Stanthorpe and at Torrington, Severn River Nature Reserve, the Barbs near Pindari Dam, Kings Plains National Park and Howell in New South Wales. Populations of this species were found at Torrington, Severn River Nature Reserve, the Barbs near Pindari Dam, Kings Plains National Park, Howell and also on private property at Parlour Mountains.

Boronia sp. J (*boliviensis* m.s.) (Family Rutaceae) (2E) (Quinn et al. 1995) is restricted to Bolivia Hill north of Glen Innes in the north-east of New South Wales. During this survey populations of this species were found on Bolivia Hill.

Brachyloma saxicola (Family Epacridaceae) (3RCa) is restricted to granitic outcrops in north-eastern New South Wales. This species was known from Torrington, Mount Jondol, Bolivia Hill, Gibraltar Range, Backwater and Mount Chaelundi. Populations were found at all of these localities with the addition of the Butterleaf area.

Callistemon flavovirens (Family Myrtaceae) (3RC-) is known from the granite belt in Queensland, Gibraltar Range State Forest (Binns 1992), Boonoo Boonoo National Park, Guy Fawkes National Park and Mann River Nature Reserve in New South Wales. The species was found in Girraween National Park.

Callistemon pungens (Family Myrtaceae) (3RC-) is known from Howell, Mount Balala, Guyra, Mann River Nature Reserve and New England National Park. Populations were found at Butterleaf, Howell, Kings Plains National Park, Parlour Mountains, Severn River and Ironbark Nature Reserves and the Willows area.

Callitris monticola (Family Cupressaceae) (3VC-) (Quinn et al. 1995) is known from south-eastern Queensland and north-eastern New South Wales. Populations of this species where found in Gibraltar Range, Boonoo Boonoo, Bald Rock and Girraween National Parks.

Cryptandra lanosiflora (Family Rhamnaceae) (3RCa) restricted to rocky exposed areas and is known from Girraween National Park in Queensland, Gibraltar Range National Park, New England National Park, Werrikimbe National Park, Black Mountain at Glen Elgin State Forest, Backwater, Bolivia Hill, the Liverpool Range and Parlour Mountains in New South Wales. This species was recorded at Backwater, Bolivia Hill, Butterleaf, Chaelundi and Gibraltar Range National Park.

Dodonaea hirsuta (Family Sapindaceae) (3RC-) is known from Copmanhurst, Bald Rock National Park, Boonoo Boonoo National Park and Torrington in New South Wales and in the Stanthorpe area of Queensland. Binns (1995) also records this species from Boorook State Forest. Populations of this species were found at Girraween National Park, Kings Plains National Park and Torrington.

Eriostemon myoporoides subsp. *epilosus* (Family Rutaceae) (3RCa) is restricted to exposed rocky outcrops. This species has been recorded from Girraween National Park in Queensland, Bald Rock National Park, Boonoo Boonoo National Park, Boorook State Forest (Binns 1995) and Bolivia Hill in New South Wales. During this survey populations were found in Bald Rock and Girraween National Parks, the Demon Nature Reserve, Bolivia Hill and Butterleaf areas.

Eucalyptus codonocarpa (Family Myrtaceae) (3RCa) is known from several disjunct localities in north-eastern New South Wales and southern Queensland. Populations were found in Cathedral Rock National Park, Backwater (including Warra State Forest and adjacent private properties), Gibraltar Range National Park, Butterleaf State Forest and Girraween National Park.

Eucalyptus mckieana (Family Myrtaceae) (2VC-) is known to occur in New South Wales between Inverell and Guyra in the Retreat, Tenterden and Gilgai areas. Populations of this species were found in Kings Plain National Park.

Eucalyptus scoparia (Family Myrtaceae) (2VCi) is restricted to the Girraween and Bald Rock National Parks. This species was recorded at Bald Rock and Girraween National Parks.

Eucalyptus youmanii (Family Myrtaceae) (2R) has been previously recorded for the Armidale and Guyra areas of the Northern Tablelands of New South Wales. This species was recorded from Flaggy Range, Howell, Moonbi, Parlour Mountains, Warrabah and Mount Yarrowyck.

Grevillea acerata (Family Proteaceae) (2RC-) is restricted to Gibraltar Range National Park and Glen Elgin in New South Wales. Populations of this species were found in Gibraltar Range National Park.

Hibbertia sp. B (Family Dilleniaceae) is a vulnerable taxon (2V) that has recorded from Torrington, Severn River and Kings Plain areas. This species was found at Torrington, Kings Plains National Park and Severn River Nature Reserve.

Hibbertia villosa (Family Dilleniaceae) (3KC-) occurs from Gibraltar Range to Werribimbee National Park. This species was recorded from Gibraltar Range National Park and the Backwater area.

Homoranthus biflorus (Family Myrtaceae) (2VC-) is known from Kings Plains National Park and the Barbs at Pindari Dam. Populations of this species were found in Kings Plains National Park.

Homoranthus lunatus (Family Myrtaceae) (2VC-) is restricted to Boonoo Boonoo National Park. This species was recorded for Torrington State Recreation Area and Boonoo Boonoo National Park.

Homoranthus papillatus (Family Myrtaceae) (2RC) is restricted to Girraween National Park in Queensland. This species was found in Girraween National Park.

Homoranthus prolixus (Family Myrtaceae) (2V) is recorded for the Howell area of New South Wales. Populations of this species were found at Howell and on private properties in the Flaggy Range.

Kunzea bracteolata (Family Myrtaceae) (3RC-) is known from the Stanthorpe district in Queensland to Guy Fawkes River National Park in New South Wales. Several populations of this species were found at Bolivia Hill, Bald Rock, Boonoo Boonoo and Girraween, Chaelundi, Eagle Creek, Gibraltar Range and Torrington.

Leucopogon cicatricatus (Family Epacridaceae) (3RCa) has been recorded from Girraween National Park and Mt Barney National Park in Queensland, Cathedral Rock National Park, New England National Park, Rowleys Rock Flora Reserve and Dingo/Bulga State Forest in New South Wales. Populations of this species were found at Girraween and Cathedral Rock National Park and at Butterleaf State Forest.

Micromyrtus grandis (Family Myrtaceae) (2EC-) is restricted to a single ridge in the Severn River Nature Reserve and adjacent private property.

Mirbelia confertiflora (Family Fabaceae) (3RCa) has been recorded from Stanthorpe and Girraween National Park in Queensland, Boonoo Boonoo National Park, Gibraltar

Range National Park and Warra and Glen Elgin State Forests. This species was noted at Girraween National Park, Gibraltar Range National Park, Eagle Creek, Warra State Forest and adjacent private properties and the Parlour Mountains.

Muehlenbeckia costata (Family Polygonaceae) (3VCa) has been recorded from Girraween National Park in Queensland, the Blue Mountains, Mount Kaputar National Park, Bald Rock National Park, Butterleaf State Forest and Crown Mountain Flora Reserve in New South Wales. Populations of this species were found in Girraween and Bald Rock National Parks and Butterleaf and Warra State Forest all after the passage of fire.

Olearia gravis (Family Asteraceae) (3KC-) grows north from Torrington and Gibraltar Range to the granite belt in Queensland. This species was recorded from Gibraltar Range National Park, Torrington, Severn River and the proposed Kwiambal National Park.

Persoonia rufa (Family Proteaceae) (2RCa) is known primarily from Gibraltar Range National Park. Populations of this species were recorded for Gibraltar Range National Park and Forest Lands State Forest near Mount Jondol.

Persoonia terminalis subsp. *terminalis* (Family Proteaceae) (2R) is known from Torrington in New South Wales. Populations of this taxon were found at Torrington and Severn River Nature Reserve.

Persoonia terminalis subsp. *recurva* (Family Proteaceae) (3R) is known from north-west of Inverell. This taxon was found commonly within the Severn River Nature Reserve, and sometimes growing sympatrically with *Persoonia terminalis* subsp. *terminalis*.

Phebalium ambiens (Family Rutaceae) (3RC-) is known from outcrops from Guyra to Stanthorpe. This species was recorded from Girraween and Bald Rock National Parks, Warra State Forest and Torrington.

Phebalium rotundifolium (Family Rutaceae) (3RC-) is known from the Stanthorpe district of Queensland, Torrington, Ballandean, Strathbogie, Kings Plain and Howell in New South Wales. This species was recorded from Girraween National Park, Torrington, Severn River Nature Reserve, Kings Plain National Park and Howell.

Plectranthus suaveolens (Family Lamiaceae) (3RC-) is known from south-eastern Queensland and Gibraltar Range in New South Wales. This species was recorded from Girraween National Park.

Prostanthera sp. B (Family Lamiaceae) (2RC-) is known from Boonoo Boonoo, Bald Rock and Girraween National Parks and Boorook and Forest Lands State Forest. This species was recorded from Bald Rock and Girraween National Parks, and was noted to germinate readily after fire.

Prostanthera staurophylla (Family Lamiaceae) (2R) restricted to the Torrington area. This species was recorded from Torrington.

Pultenaea stuartiana (Family Fabaceae) (3VC-) is recorded from Torrington, Girraween National Park and from the Severn River area. This species was recorded from Torrington and Girraween National Park.

Thelionema grande (Family Phormiaceae) (3RC-) is known from Girraween, Mount Barney, Boonoo Boonoo, Bald Rock, Gibraltar Range and Werrikimbe National Parks, Boonoo State Forest, Torrington, Bolivia Hill and Howell. Populations of this species were found at Bald Rock and Girraween National Parks, Ironbark Nature Reserve, Howell, Bolivia Hill and on private property in the Backwater area.

Zieria odorifera (Family Rutaceae) (3RCi) is restricted mainly to the Nandewar and Warrumbungle Ranges. This species was recorded from Howell, Warrabah National Park and private properties in the Willows area.

Other Restricted Taxa

Acacia sp. aff. *torringtonensis* (Family Fabaceae) is a recently discovered species from Gibraltar Range whose ROTAP status is probably 2VCt (Rod Jones, Department of Botany, UNE, pers. comm.). This species is only known from three localilies within close proximity in Gibraltar Range National Park. This species was found at one of the previously recorded localities.

Dodonaea stenophylla (Family Sapindaceae) occurs in the Northern Territory and Queensland, however it is considered as rare in New South Wales. Harden (1990–1993) lists this species as occurring in the Bingara district, however it is listed under those presumed extinct in New South Wales by the threatened species act 1995 (TSC Act). A single population of this species was found on land held under a permissive occupancy in the Howell area.

Eucalyptus sp. aff. *cypellocarpa* (*quinniorum* m.s. J.T. Hunter & J.J. Bruhl) (Family Myrtaceae) (J.T. Hunter 3723, V.H. Hunter & J. Vollmer) is a new taxon that warrants a ROTAP coding of 2RC-. This taxon was found at Warrabah National Park and surrounding private properties, Ironbark Nature Reserve, Flaggy Range, Mount Lookout and Moonbi.

Hibbertia linearis var. *grandiflora* (Family Dilleniaceae) warrants a ROTAP code of 2V- (Nano 1996). This species was found at Moore Creek Gap near Moonbi and Attunga State Forest.

Hibbertia sp. aff. *monogyna* (Family Dilleniaceae) is a restricted taxon that appears to only occur in the Backwater and Mount Yarrowyck areas of New South Wales and warrants a ROTAP code of 2V- (Nano 1996). Populations of this taxon were found at Backwater, Parlour Mountains and Mount Yarrowyck.

Homoranthus bornhardtiensis m.s. (J.T.Hunter 5550) (Family Myrtaceae) is a new taxon from the Ironbark Nature Reserve and surrounding private properties that warrants a ROTAP code of 2VC-.

Homoranthus croftianus m.s. (J.T.Hunter 5167) (Family Myrtaceae) is a new taxon from Bolivia Hill that warrants a ROTAP code of 2V.

Monotaxis macrophylla (Family Euphorbiaceae) is a species listed as endangered in New South Wales (TSC Act). It has only been recorded a few times in New South Wales, from the Cobar district, Howell (Maiden 1906) and the south coast were it was found to germinate after wildfires. Large populations of this species were found in

Warra State Forest after the passage of a wildfire. All traces of this species had gone after one year.

Pseudanthus pimeleoides (Family Euphorbiaceae) is recorded from Tasmania and Victoria. Although this species was recorded for New South Wales and Queensland these reports were unsubstantiated with the putative New South Wales record from the south coast (James, T. 1995, pers. comm.). It was thought to be extinct in New South Wales (TSC Act). During the survey, this species was found in the Torrington area.

Appendix 2.

List of vascular plant species recorded from granitic outcrops of the New England Batholith.

Note that authorities are given only for species that are not in the Flora of NSW (Harden 1990–1993).

Family	Taxon	Community
Acanthaceae	*Rostellularia adscendens*	8a
Amaranthaceae	*Alternathera denticulata*	8a
Anthericaceae	*Arthropodium milleflorum.*	1a, 1c, 4a, 4b, 6a, 6b, 7a, 7c, 7d, 7f, 7g, 7h, 8a, 9a, 9b
	Arthropodium minus	7c
	Caesia calliantha	9a
	Dichopogon fimbriatus.	7a, 7c, 7g, 9a, 9b
	Laxmannia compacta.	1b, 1c, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 7a, 7c, 7d, 7e, 7f, 7g, 7h, 9a
	Laxmannia gracilis	1c, 2e, 3a, 9a
	Thysanotus tuberosus subsp. *tuberosus*	2d
	Tricoryne elatior	1c, 5a, 7c, 8a
Apiaceae	*Actinotus gibbonsii*	1a, 1b, 2a, 2d, 2e, 7a, 7e, 7g, 9a, 9b
	Actinotus helianthi.	2d, 2f, 4b, 5b, 7a, 7c, 7e, 8a, 9a, 9b
	Hydrocotyle geraniifolia	2d
	Hydrocotyle peduncularis	2d, 6a, 7a, 7c, 7e, 7f, 7g, 8a, 9a
	Hydrocotyle tripartita	7a
	Platysace ericoides	2a, 2d, 2e, 2f, 3a, 4a, 5a, 5b
	Platysace lanceolata	1a, 1b, 1c, 2a, 2b, 2c
	Trachymene incisa	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 5b, 6b, 7a, 7b, 7e, 7f, 7g, 7h, 8a, 9a, 9b
	Trachymene sp. aff. *pilosa*	1a, 1b, 1c, 2a, 2c, 4a
	Xanthosia pilosa	2e
Araliaceae	*Astrotricha longifolia*	1b, 2a, 2b
	Astrotricha roddii	5a, 5b, 7d, 8a
	Polyscias sumbucifolius	1a, 1b, 2a, 2c

Family	Taxon	Community
Asclepiadaceae	**Gomphocarpus fruticosus*	7g
	Marsdenia rostrata	2d
Asphodelaceae	*Bulbine semibarbata*	6b, 7a
Aspleniaceae	*Asplenium flavellifolium*	1a, 1b, 1c, 2a, 2b, 2d, 2f, 4c, 5a, 7f, 7g, 7h
	Pleurosorus subglandulosus	6b, 7a, 7d, 7f, 7g, 8a, 9a
Asteraceae	*Actinobole uliginosum*	7g
	**Bidens pilosa*	6a, 6b, 8a, 9b
	**Bidens subalternans*	6a, 7g
	Brachyscome microcarpa	1a
	Brachyscome multifida	7g
	Brachyscome stuartii	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 6b, 7a, 7c, 7e, 7f, 7g, 8a, 9a, 9b
	Calotis cuneifolia	6a, 7c, 7g
	Calotis hispidula	8a
	Calotis lappulaceae	6a, 6b
	**Carduus tenuiflorus*	1a, 6b
	Cassinia aculeata	2d, 7a
	Cassinia laevis	1b, 2b, 6a, 7c, 7d, 7g, 9a, 9b
	Cassinia quinquefaria	2f, 4b, 7a, 7c, 7e, 7f, 7g, 7h, 9a
	Cassinia uncata	2d, 2e, 4b, 6a, 6b, 7d, 7g, 7h
	Chrysocephalum apiculatum	2d, 7e, 7f, 7g
	Chrysocephalum semipapposum	6b, 7g, 9b
	**Conyza albida*	1a, 7a
	**Conyza bonariensis*	2d, 2e, 2f, 4b, 7g, 9b
	Cotula australis	9b
	Cymbonotus lawsonianus	7g
	**Dimorphotheca pluvialis*	6b
	Euchiton involucratus (G. Forst.) Holub	2f, 7a, 7f, 7g
	Euchiton sphaericus (Willd.) Holub	1a, 1c, 3a, 4b, 6a, 7e, 7g, 9a
	**Gnaphalium americanum*	2d, 2f
	Helichrysum boormanii	2a
	Helichrysum elatum	1b, 2a, 2d, 4a
	**Hypochaeris glabra*	6b

Family	**Taxon**	**Community**
Asteraceae cont.	**Hypochaeris radicata*	1a, 1b, 1c, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 6b, 7a, 7b, 7c, 7d, 7f, 7g, 7h, 8a, 9a, 9b
	Lagenifera gracilis	2a
	Lagenifera stipitata	7e, 7g
	Olearia elliptica	2e, 6b, 7c, 7d, 7e, 7g, 9b
	Olearia gravis	7d, 8a
	Olearia microphylla	7a
	Olearia oppositifolia	1a, 2b, 2d
	Olearia ramosissima	4b, 8a
	Olearia viscidula	7f, 7g, 7h
	Ozothamnus diosmifolius	2d, 3a, 7g
	Ozothamnus obcordatus	4b, 5a, 5b, 7c, 7d, 7e, 7f, 7g, 7h, 9a
	Podolepis neglecta	7c
	Senecio daltonii	5a, 7d
	Senecio diaschides	7a
	Senecio hispidulus	6a, 6b
	Senecio lautus	6a, 7f
	Senecio sp. E	1a, 2d
	Sigesbeckia australis	6b, 9b
	**Silybum marianum*	7h
	Solenogyne bellioides	1a, 1c, 2c, 2d, 2f, 3a, 4a, 6b, 7e, 7f, 7g, 7h, 9a
	Solenogyne dominii	1c
	**Sonchus asper*	2e, 2f
	**Sonchus oleraceus*	2d, 7d, 7g, 8a
	**Taraxacum afficinale*	3a
	Vittadinia cuneata	5a, 7a, 7g
	Vittadinia dissecta	1c, 6a, 6b
	Vittadinia muelleri	8a
	Vittadinia sulcata	5a, 6a, 6b, 7f, 7g, 8a, 9b
Bignoniaceae	*Pandorea pandorana*	7a, 7g, 8a
Blechnaceae	*Blechnum cartilagineum*	2a, 9a
	Doodia aspera	2a

Family	Taxon	Community
Boraginaceae	*Cynoglossum australe*	6b
Brassicaceae	*Lepidium pseudohyssopifolium*	9b
	Rorippa laciniata	7g
Cactaceae	**Opuntia aurantiaca*	6a, 6b, 8a, 9a, 9b
	**Opuntia stricta*	6a, 6b, 7d, 7g, 7h, 8a, 9a, 9b
Campanulaceae	*Wahlenbergia communis*	4b, 6a, 6b, 7a, 7g, 9a, 9b
	Wahlenbergia gracilis	1a, 2c, 6b
	Wahlenbergia graniticola	4b, 5a, 5b, 7a, 7b, 7d, 7f, 7g, 8a
	Wahlenbergia luteola	1a, 1c, 2d, 5a, 7a, 7f, 7g
Caryophyllaceae	**Paronychia brasiliana*	5a
	**Petrorhagia nanteuilii*	6b, 7g, 9b
	Scleranthus biflorus	7h
	**Stellaria media*	2d, 7a, 7b, 7d, 7g, 7h
Casuarinaceae	*Allocasuarina brachystachya*	5a, 5b
	Allocasuarina gymnanthera	5a
	Allocasuarina inophloia	5a, 5b, 7d
	Allocasuarina littoralis	1b, 2a, 2b, 2d, 2e, 2f, 4a
	Allocasuarina rigida subsp. *rigida*	1a, 1b, 1c, 2a, 2c, 3a, 4a
	Allocasuarina rupicola	2d
	Allocasuarina torulosa	2a
	Casuarina cunninghamiana	7g, 8a
Celastraceae	*Maytenus silvestris*	2a
Centrolepidaceae	*Centrolepis strigosa*	7e, 7f, 9a
Chenopodiaceae	*Chenopodium carinatum*	6a
	Chenopodium pumilio	1a, 1c, 2d, 6a, 7d, 7e, 8a, 9b
	Einadia hastata	6b, 7b, 7d, 7e, 7g, 7h, 9b
	Einadia nutans	6b
	Einadia trigonos	f5b
Chloanthaceae	*Chloanthes parviflora*	1b, 2a, 2b, 2d
Clusiaceae	*Hypericum gramineum*	2d, 3a, 4a, 4b, 5a, 6b, 7a, 7f, 7g, 9a
Colchicaceae	*Wurmbea biglandulosa*	4b, 7a, 7g
Commelinaceae	*Commelina cyanea*	2d, 4a, 5a, 6b, 7a, 7c, 7d, 7f, 7g, 8a, 9a, 9b
	Murdannia graminea	2c, 5a, 6b, 7a, 7g, 9b

Family	Taxon	Community
Convolvulaceae	*Dichondra repens*	2e, 7a, 7f
	Dichondra sp. A	1c, 6a, 6b, 7g, 9b
	Evolvulus alsinoides	6a, 6b, 7g, 8a
	**Ipomoea cairica*	6a
Crassulaceae	*Crassula sieberiana*	1a, 1c, 2d, 2e, 2f, 4b, 6a, 6b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a, 9b
Cucurbitaceae	**Citrullus lanatus*	9b
Cupressaceae	*Callitris endlicheri*	2d, 2f, 4a, 4b, 4c, 5a, 5b, 6a, 7a, 7c, 7d, 7f, 7g, 7h, 8a, 9a, 9b
	Callitris glaucophylla	6b, 7g, 8a
	Callitris monticola	2a, 2d, 2e, 2f, 3a
	Callitris rhomboidea	2d
Cyatheaceae	*Cyathea australis*	1c, 2c, 9a
Cyperaceae	*Bulbostylis barbata*	8a
	Bulbostylis densa	1a, 1b, 1c, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 7a, 7e, 7g, 8a
	Bulbostylis pyriformis	9a, 9b
	Carex appressa	7g
	Carex gaudichaudiana	2c
	Caustis flexuosa	2a, 3a, 7e, 3a, 4b
	Cyperus fulvus	4b, 5a, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 8a, 9a
	Cyperus gracilis	6a, 6b, 7g, 9b
	Eleocharis sphacelata	2e
	Fimbristylis dichotoma	1a, 1b, 1c, 2d, 2f, 3a, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a, 9b
	Gahnia aspera	1a, 2d, 2f, 4a, 4b, 4c, 7a, 7b, 7c, 7d, 7f, 7g, 9a, 9b
	Gahnia sieberiana	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 7e
	Gymnoschoenus sphaerocephalus	1c
	Isolepis hookeriana	7f
	Lepidosperma gunnii	1a, 1b, 1c, 2a, 2b, 2e, 2f, 3a, 4a, 4b, 7a
	Lepidosperma laterale	1a, 1b, 1c, 2a, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 9a, 9b
	Lepidosperma neesii	2a, 3a
	Lepidosperma tortuosum	2b
	Schoenus apogon	1a, 1b, 1c, 2a, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 7d, 7g, 7h

Family	**Taxon**	**Community**
Cyperaceae cont.	*Schoenus brevifolius*	2d
	Schoenus melanostachys	1b, 2a, 2d, 2e, 3a
	Schoenus turbinatus	3a
	Scirpus polystachyus	1a, 1b
	Scleria mackaviensis	4b, 6a, 8a
Davalliaceae	*Davallia pyxidata*	1a, 1c, 2a, 2d, 2f, 4a, 4b, 4c, 7a
Dennstaedtiaceae	*Calochlaena dubia*	1a, 2a, 3a
	Pteridium esculentum	1a, 1b, 1c, 2a, 2c, 2d, 2f, 3a, 4b, 7g, 7h
Dilleniaceae	*Hibbertia acicularis*	1a, 1b, 1c, 4c, 5a
	Hibbertia aspera	2d, f1c, f1d, f3a
	Hibbertia cistoidea	2d
	Hibbertia kaputarensis	7c
	Hibbertia linearis	2d, 7c, 7f, 9a
	Hibbertia monogyna	1a, 7e
	Hibbertia obtusifolia	2a, 2d, 4c, 5a, 7d, 7f, 7g, 8a
	Hibbertia riparia	1b, 2a, 2e, 4a, 4b, 5a, 5b, 7d, 7e, 9a
	Hibbertia scandens	2a
	Hibbertia serpyllifolia	1a, 1b, 1c, 2a, 3a, 4b
	Hibbertia sp. *'grandiflora'* m.s.	6a, 6b
	Hibbertia sp. B	4b, 4c, 5a, 5b, 7d
	Hibbertia villosa	1c, 3a
Droseraceae	*Drosera auriculata*	2d
	Drosera peltata	1b, 1c, 2b, 3a, 4b, 5a, 5b, 7a, 7b, 7f, 7g, 8a, 9a
	Drosera spatulata	2e, 3a
Elaeocarpaceae	*Elaeocarpus holopetalus*	2a, 2c, 2d, 2f
	Elaeocarpus reticulatus	1b, 2a
Epacridaceae	*Acrotriche aggregata*	2a, 2b, 2d, 2e, 2f
	Brachyloma daphnoides subsp. *glabrum* (Blakely) J.T. Hunter	1a, 1c, 2d, 2f, 4b, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g
	Brachyloma saxicola J.T. Hunter	1a, 1b, 1c, 2a, 2b, 3a, 4a, 4b, 4c, 7a
	Epacris longiflora	2a, 3a
	Epacris microphylla var. *microphylla*	1b, 1c, 2c, 3a
	Epacris obtusifolia	3a

Family	Taxon	Community
Epacridaceae cont.	*Leucopogon attenuatus*	5a, 5b, 8a
	Leucopogon biflorus	4b, 4c, 7e
	Leucopogon cicatricatus J.M. Powell	1b, 2a, 2c, 2f
	Leucopogon lanceolatus var. *lanceolatus*	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2f, 3a
	Leucopogon melaleucoides	2a, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 5b, 7c, 7d, 7e, 7g, 9a, 9b
	Leucopogon microphyllus	1a, 1b, 1c, 3a, 4a, 4b, 5a
	Leucopogon muticus	4a, 4b, 5a, 5b, 7a, 7c, 7d, 7e, 7f, 7g, 9a
	Leucopogon neo-anglicus	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 5b, 7a, 7e, 7f, 9a, 9b
	Lissanthe strigosa	5a, 5b, 7f
	Melichrus erubescens	4b
	Melichrus procumbens	2e, 3a
	Melichrus urceolatus	2d, 4a, 4b, 5a, 5b, 6a, 7a, 7c, 7d, 7e, 7f, 7g, 7h, 8a
	Monotoca scoparia	1a, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4b, 5a, 7a, 7e
	Styphelia triflora	2a, 4b, 4c, 5a, 5b, 8a
	Styphelia viridis	2d, 2f
	Trochocarpa laurina	2a
	Trochocarpa sp. A	2c
Escalloniaceae	*Quintinia sieberi*	2f
Euphorbiaceae	*Amperea xiphoclada* var. *xiphoclada*	2a, 2d, 2e, 2f
	Bertya cunninghamii	2a, 6b
	Bertya gummifera	5a, 5b
	Bertya oleifolia	8a
	Beyeria viscosa	7d, 7g, 8a
	Chamaesyce drummondii	7g, 8a
	Euphorbia eremophila	6a
	Micrantheum ericoides	4b
	Micrantheum hexandrum	2d, 7a
	Monotaxis macrophylla	1a, 1b
	Phyllanthus carpentariae Muell. Arg.	8a
	Phyllanthus hirtellus	2e, 3a
	Phyllanthus occidentalis J.T. Hunter & J.J. Bruhl	4b, 5b, 7d
	Phyllanthus subcrenulatus	7g

Family	Taxon	Community
Euphorbiaceae cont.	*Phyllanthus virgatus*	1a, 6a, 7d, 8a
	Poranthera corymbosa	4b
	Poranthera microphylla	1a, 2d
	Pseudanthus divaricatissimus	1c
	Pseudanthus ovalifolius	4b
	Pseudanthus pimeleoides	3a
Fabaceae	*Acacia adunca*	2d, 2f, 4a, 7a
	Acacia barringtonensis	3a
	Acacia betchei	4b
	Acacia brownei	2d
	Acacia brunioides	3a
	Acacia buxifolia	5a, 5b, 7a
	Acacia cheelii	7f, 7g
	Acacia eborensis m.s.	7e
	Acacia falcata	7c
	Acacia falciformis	1a, 1c, 2a, 2b, 2c, 2d, 2e, 3a, 4b, 4c, 5a, 7g, 9a
	Acacia fimbriata	7a
	Acacia floydii	2a, 2d
	Acacia granitica	4b, 7e, 7g, 9a
	Acacia gunnii	5a
	Acacia juncifolia	7a
	Acacia latisepala	2d, 2e, 2f, 4b
	Acacia leiocalyx	7g, 8a
	Acacia longifolia	1b, 2a
	Acacia macnuttiana	2d, 4b, 7a, 7d
	Acacia neriifolia	4b, 5a, 6a, 6b, 7a, 7c, 7d, 7f, 7g, 7h, 9a, 9b
	Acacia obtusifolia	1b, 2a, 2b, 3a, 4a
	Acacia penninervis	5b, 7f, 7g
	Acacia polybotrya	5b
	Acacia pruinosa	5a, 5b, 7a, 7c, 7g
	Acacia pycnostachya	4a, 7a
	Acacia rubida	7a

Family	**Taxon**	**Community**
Fabaceae cont.	*Acacia* sp. aff. *torringtonensis*	3a
	Acacia stricta	7e
	Acacia suaveolens	2a, 3a
	Acacia torringtonensis	4b, 5a, 5b
	Acacia triptera	7c, 7e, 7f, 9a, 9b
	Acacia ulicifolia	1a, 1b, 1c, 2b, 2d, 2e, 3a, 4b, 5a, 5b, 7g, 7h
	Acacia venulosa	1a, 1b, 1c, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 7a, 7e
	Acacia viscidula	1a, 1b, 1c, 2b, 2d, 2e, 2f, 4a, 4b, 6b, 7a, 7b, 7e, 7f, 7g, 9a
	Acacia williamsiana J.T. Hunter	5a, 5b, 8a
	Aotus subglauca	1a, 1b, 2d, 4b, 5a, 5b, 7e
	Bossiaea neo-anglica	1a, 2a, 3a
	Bossiaea obcordata	4c
	Bossiaea rhombifolia	1a, 1c, 2d, 4b
	Bossiaea scortechinii	1a, 2a, 4b
	Daviesia latifolia	f1c, f2a, f4b
	Daviesia ulicifolia subsp. *pilligensis* G. Chandler & Crisp	4b, 5b
	Desmodium brachypodum	6a, 6b
	Desmodium varians	2d, 7g
	Dillwynia phylicoides	1a, 1b, 1c, 2c, 2e, 3a, 4a, 7c, 7g
	Dillwynia retorta	7e
	Dillwynia sieberi	2a, 3a, 5a, 7g
	Glycine clandestina	2d, 6a, 6b, 7a, 7f, 7g, 9b
	Glycine microphylla	2d
	Glycine tabacina	7g
	Gompholobium huegelii	4b
	Hardenbergia violacea	2a, 2b, 2d, 2f, 4a, 4b, 7a, 7g, 7h
	Hovea lanceolata	3a, 4b, 5a, 5b, 6b, 7a, 7c, 7d, 7g, 8a, 9a
	Hovea purpurea	2d, 2e
	Hovea sp. A	1a, 1b, 1c, 2a, 2d, 2f, 3a, 4a, 4b, 7b, 7e, 7f, 7g
	Indigofera australis	4b
	Jacksonia scoparia	2d, 7a, 8a
	Mirbelia confertiflora	1a, 1b, 1c, 2e, 3a, 4a, 7a, 7e

Family	Taxon	Community
Fabaceae cont.	*Mirbelia pungens*	2d, 3a, 4b, 7c, 7f, 7g, 8a
	Mirbelia rubiifolia	3a, 4b, 7a
	Mirbelia speciosa subsp. *speciosa*	1b, 2b, 2d, 2e, 2f, 3a, 4b, 5a, 5b
	Phyllota phylicoides	2a, 3a
	Podolobium arborescens (R.Br.) Crisp	2f
	Podolobium ellipticum (Vent.) Crisp	7g
	Podolobium ilicifolium (Andrews) Crisp	2a, 2d
	Pultenaea foliolosa	5a, 5b
	Pultenaea retusa	3a
	Pultenaea sp. B	3a
	Pultenaea sp. C	5a, 7c, 7g
	Pultenaea sp. aff. *obovata*	2a
	Pultenaea stuartiana	2e, 4b
	Senna artemisioides	7d
	Swainsona galegifolia	6a
	**Trifolium repens*	6a, 6b, 7g, 7h, 9b
Geraniaceae	**Geranium molle*	6b
	Geranium solanderi var. *grande*	6a
	Geranium solanderi var. *solanderi*	2d, 6a, 7g
	Pelargonium australe	2d, 2e, 7g
Gleicheniaceae	*Gleichenia dicarpa*	1c
Goodeniaceae	*Dampiera lanceolata*	5a, 5b
	Dampiera stricta	1a, 2a, 3a
	Goodenia bellidifolia subsp. *argentea*	1a, 1b, 2b, 2d, 2e, 3a, 4b, 5a, 5b, 6a, 7a, 7c, 7g, 9a
	Goodenia hederacea	1a, 1c, 2d, 2e, 3a, 4a, 4b, 5b, 7a, 7d, 7e, 7g, 8a
	Velleia paradoxa	1a, 2a
Haemodoraceae	*Haemodorum planifolium*	3a
Haloragaceae	*Gonocarpus elatus*	8a
	Gonocarpus micranthus subsp. *micranthus*	1a, 1b, 1c, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 7c, 7e, 7f, 9a
	Gonocarpus oreophilus	1b, 2a, 2d, 2e, 2f, 3a, 4a
	Gonocarpus tetragynus	1c, 2a, 2b, 2d, 4b, 5a, 6b, 7a, 7e, 7f, 7g, 8a, 9a
	Gonocarpus teucrioides	1a, 1b, 1c, 2a, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 6b, 7a, 7b, 7c, 7e, 7g, 7h, 9a, 9b

Family	Taxon	Community
Haloragaceae cont.	*Haloragis aspera*	7a, 7g
Hypoxidaceae	*Hypoxis exilis*	7a
Iridaceae	*Patersonia glabrata*	1b, 1c, 2a, 2e, 3a, 4b
	Patersonia sericea	1a, 1b, 1c, 2a, 2b, 2d, 2e, 3a, 4a, 4b, 4c, 5a, 7a, 7e, 9b
Juncaceae	*Juncus bufonius*	2d, 2e, 8a, f4a
	Juncus continuus	2d, 2e, 4a, 4b, 7g
	Juncus firmus	1b
	Juncus laeviusculus	7a
	Juncus remotiflorus	1c, 2a, 4b, 4c, 7g, 8a, 9a
	Juncus subsecundus	4b
	Luzula flaccida	1a, 1c, 3a, 7e
Lamiaceae	*Ajuga australis*	1a, 2d, 7f, 7g
	**Marrubium vulgare*	7g
	Mentha diemenica	7e
	Plectranthus graveolens	1c, 2d, 4a, 7a
	Plectranthus parviflorus	2d, 4a, 5a, 7a, 7g, 8a, 9a, 9b
	Plectranthus suaveolens	2d, 2e, 2f
	Prostanthera howelliae	7f
	Prostanthera nivea	2b, 4a, 4b, 5a, 5b, 6b, 7a, 7b, 7c, 7e, 7f, 7g, 9a, 9b
	Prostanthera saxicola	2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 8a
	Prostanthera scutellarioides	1a, 1c, 2c, 3a
	Prostanthera sp. B	2d, 2f
	Prostanthera staurophylla	4b
	Prunella vulgaris	2d
	Scutellaria humilis	6b
	Westringia eremicola	9a
Lauraceae	*Cassytha filiformis*	2a, 2c, 3a, 4a, 4b
	Cassytha globella	3a, 5a, 7a
	Cassytha pubescens	2e, 4b, 5a, 5b, 7e, 7g
Lindsaeaceae	*Lindsaea linearis*	1b, 1c, 3a
Lobeliaceae	*Isotoma anethifolia*	1b, 2d, 2e, 2f, 4a, 5b, 7a, 7c, 7f, 9a, 9b
	Isotoma axillaris	1c, 4b, 4c, 5a, 5b, 6a, 6b, 7a, 7b, 7c, 7d, 7e, 7g, 7h, 9a, 9b

Family	**Taxon**	**Community**
Lobeliaceae cont.	*Lobelia gibbosa*	2d, 2f, 7a
	Lobelia gracilis	2b, 4a, 4b, 4c, 5a, 7a, 7b, 7c, 7e, 7f, 7g, 7h, 8a, 9a, 9b
	Pratia purpurascens	2d, 2e, 7a
Loganiaceae	*Logania albiflora*	4b
Lomandraceae	*Lomandra confertifolia*	2d
	Lomandra cylindrica	7e
	Lomandra filiformis subsp. *filiformis*	1a, 2e, 3a, 4b, 5a, 5b, 7a, 7c, 7e, 7g, 8a, 9a
	Lomandra longifolia	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 6b, 7a, 7c, 7e, 7f, 7g, 7h, 8a
	Lomandra multiflora	4b, 5a, 5b, 7a, 7c, 7d, 7f, 7g, 8a, 9b
Loranthaceae	*Amyema cambagei*	2d, 4b, 7g
	Amyema miquelii	4b, 4c, 5b, 7f, 7g
	Amyema pendulum	2b, 2d, 4b, 4c, 7a, 7c, 7g, 7h, 9a
	Muellerina celastroides	9a
	Muellerina eucalyptoides	4a, 7d, 8a
Luzuriagaceae	*Eustrephus latifolius*	1a, 2d, 6b
Lycopodiaceae	*Lycopodium laterale*	2e
Moraceae	*Ficus rubiginosa*	4a, 4c, 6b, 7a, 7g, 8a, 9a
Myoporaceae	*Myoporum montanum*	6b
Myrtaceae	*Angophora floribunda*	7f, 7g, 8a, 9a
	Babingtonia densifolia (Sm.) F. Muell.	4b, 5a, 5b, 7e, 7g, 9a, 9b
	Babingtonia odontocalyx A.R. Bean	4b, 4c
	Baeckea omissa A.R. Bean	3a, 7e
	Callistemon citrinus	4b, 8a
	Callistemon comboynensis	3a
	Callistemon flavovirens	2d
	Callistemon pallidus	1a, 1c, 2d, 2e, 2f, 3a
	Callistemon pungens	1b, 7a, 7c, 7f
	Calytrix tetragona	1a, 1b, 1c, 2f, 3a, 4a, 4b, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 9a
	Corymbia dolichocarpa (D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson	8a
	Eucalyptus acaciiformis	1a, 1b, 3a

Family	**Taxon**	**Community**
Myrtaceae cont.	*Eucalyptus albens*	7a, 7g
	Eucalyptus andrewsii	1b, 2a, 2b, 2d, 4b, 4c, 7a, 7c, 7e
	Eucalyptus banksii	2d, 2e, 2f
	Eucalyptus bridgesiana	2a, 4a
	Eucalyptus brunnea	2b
	Eucalyptus caleyi	5a, 5b, 7a, 7c, 7f
	Eucalyptus caliginosa	1a, 1c, 2c, 4a
	Eucalyptus campanulata	1b, 2a, 2d, 2e, 2f
	Eucalyptus codonocarpa	1a, 1b, 1c, 2a, 2e, 2f, 3a
	Eucalyptus crebra	5a
	Eucalyptus dalrympleana	1a, 1c, 2e, 2f
	Eucalyptus dealbata	2d, 2f, 4a, 4b, 5a, 5b, 6b, 7a, 7c, 7d, 7e, 7f, 7g, 8a, 9a, 9b
	Eucalyptus ligustrina	3a
	Eucalyptus macrorhyncha	7d, 7f
	Eucalyptus mckieana	5a
	Eucalyptus notabilis	3a
	Eucalyptus prava	2d, 2f, 4a, 4b, 4c, 5a, 5b, 6a, 6b ,7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a, 9b
	Eucalyptus quinniorum m.s. (sp. aff. *cypellocarpa)*	7f, 7g, 7h
	Eucalyptus radiata	2f, 3a
	Eucalyptus scias subsp. *apoda*	2a, 2d
	Eucalyptus scoparia	2d, 2f
	Eucalyptus williamsiana	1b
	Eucalyptus youmanii	7g, 7h
	Homoranthus biflorus	5a
	Homoranthus bornhardtiensis m.s.	7f
	Homoranthus papillatus	2d, 2e
	Homoranthus croftianus m.s.	4a
	Homoranthus prolixus	7c, 7f, 7g, 9a, 9b
	Kunzea bracteolata	2a, 2d, 2e, 2f, 3a, 4a, 4b, 7a
	Kunzea obovata	1a, 1b, 1c, 2a, 4a, 4b, 5a, 5b, 7a, 7e, 7g
	Kunzea opposita	2b
	Kunzea parvifolia	7a, 7f

Family	Taxon	Community
Myrtaceae cont.	*Leptospermum arachnoides*	3a, 4b, 5b
	Leptospermum brachyandrum	3a, 7c
	Leptospermum brevipes	1a, 1c, 2d, 2f, 4a, 4b, 4c, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a
	Leptospermum minutifolium	3a
	Leptospermum novae-angliae	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 7a, 7e, 7f, 7g, 7h, 9a
	Leptospermum polygalifolium subsp. *transmontanum*	1b, 2a, 2d, 2f
	Leptospermum trinervium	2a, 2d, 3a, 4b, 4c
	Leptospermum variabile	2e, 7f
	Lophostemon confertus	2a, 2d
	Micromyrtus grandis J.T. Hunter	5a
	Micromyrtus sessilis	2b, 2f, 4a, 4b, 5b, 7a, 7g, 9a
	Syzigium luehmannii	2a
Nyctaginaceae	*Boerhavia dominii*	2d, 6a
Olacaceae	*Olax stricta*	4b, 5a, 5b
Oleaceae	*Notelaea linearis*	1c, 2a, 2d, 2e, 4b, 7a, 7d, 8a
	Notelaea microcarpa	6a, 6b, 7a, 7f, 7g, 9a
	Notelaea sp. A.	1a, 1b, 2a, 2b, 2c, 2f
Ophioglossaceae	*Ophioglossum lusitanicum*	6b
Orchidaceae	*Acianthus apprimus*	2a, 2d
	Acianthus collinus	7f
	Acianthus exsertus	7f
	Bulbophyllum elisae	2a, 2d, 4a
	Caladenia catenata	7a
	Caladenia fuscata	1a, 1c, 4b
	Caladenia tentaculata	7g
	Calochilus campestris	1c
	Chiloglottis reflexa	1c, 2e, 3a, 7g
	Chiloglottis sp.	2d
	Corybas fimbriatus	2b
	Cryptostylis subulata	1b, 1c, 2a, 2d, 2e, 2f, 3a, 4a, 4b, 7a
	Cymbidium canaliculatum	7g
	Dendrobium kingianum	2b, 2d, 2e

Family	Taxon	Community
Orchidaceae cont.	*Dendrobium pugioniforme*	2d, 2e, 3a
	Dendrobium speciosum	2a, 2d
	Dipodium variegatum	6b
	Diuris abbreviata	4b, 7a
	Genoplesium fimbriatum	3a
	Glossodia major	5b
	Microtis unifolia	1c
	Prasophyllum brevilabre	1a, 1b, 3a, 4b
	Pterostylis boormanii	7g
	Pterostylis coccinea	5a, 7f
	Pterostylis daintreana	2a, 2d, 2f, 4b, 5a, 5b, 7b, 7d, 7g, 8a
	Pterostylis decurva	1a, 1b
	Pterostylis fischii	1a
	Pterostylis furcata	4a
	Pterostylis longifolia	1c, 2c, 2d, 2e, 2f, 3a, 4a, 7g
	Pterostylis mutica	4b, 7a, 7g
	Pterostylis parviflora	3a, 5a
	Pterostylis praetermissa	7g
	Pterostylis reflexa	7e
	Pterostylis setifera	4b, 9a
	Pterostylis woollsii	9a
	Thelymitra pauciflora	1b, 4b
Oxalidaceae	*Oxalis chnoodes*	2d, 6b, 7a, 7g, 9a, 9b
	Oxalis exilis	6a
	Oxalis perennans	6a, 7d, 8a
	Oxalis radicosa	9a
Phormiaceae	*Dianella caerulea* var. *assera*	2a
	Dianella caerulea var. *caerulea*	1a, 2a, 2b, 2c, 2d, 3a, 4a, 4b, 5a, 5b, 7a, 7c, 7d, 7e, 7f, 7g, 8a, 9a, 9b
	Dianella longifolia	9a
	Dianella revoluta	1c, 2a, 2b, 2d, 2e, 2f, 4a, 4b, 4c, 5a, 5b, 6b, 7a, 7d, 7g
	Dianella tasmanica	1a, 1b, 1c, 2a, 2c, 3a, 4a, 4b, 7a
	Stypandra glauca	1a, 1b, 2b, 2d, 2e, 2f, 4a, 4b, 5a, 5b, 6b, 7a, 7b, 7c, 7e, 7f, 7g, 7h, 8a, 9a

Family	Taxon	Community
Phormiaceae cont.	*Thelionema caespitosum*	1a, 1b, 1c, 2c, 3a, 7c, 7h
	Thelionema grande	2d, 2e, 2f, 4a
Phytolaccaceae	**Phytolacca octandra*	1b, 2d, 2f, 3a, 6a
Pittosporaceae	*Billardiera scandens*	1a, 1c, 2d
	Bursaria spinosa	1a, 2a, 6b, 7g
	Rhytidosporum procumbens	5a, 5b, 8a
Plantaginaceae	*Plantago debilis*	6b, 7e, 7g
	**Plantago lanceolata*	7g, 9a
	Plantago varia	7d
Poaceae	*Agrostis avenacea*	7e
	Agrostis sp. A	2c
	Amphipogon strictus	3a
	Aristida jerichoensis subsp. *subspinulifera*	1b, 2a, 2b, 2d, 2e, 2f, 4a, 4b, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a
	Aristida ramosa	1c, 2e, 3a, 4a, 4b, 6a, 7c, 8a
	Aristida vagans	6a, 6b, 7a, 7d, 7f, 7g, 8a, 9a, 9b
	Arundinella nepalensis	4b, 7a, 7c, 7d, 7g, 8a, 9a
	Austrodanthonia induta (Vickery) H.P. Linder	7e
	Austrodanthonia linkii (Kunth) H.P. Linder	2b, 2d, 2e, 2f, 5a, 6b, 7a, 7c, 7e, 7f, 7g, 9a, 9b
	Austrodanthonia monticola (Vickery) H.P. Linder	1a, 1b, 1c, 2c, 4a, 4b, 5a, 5b, 7a, 7b, 7d, 7f, 7g, 7h ,9a
	Austrodanthonia penicillata (Labill.) H.P. Linder	7d
	Austrodanthonia pilosa (R.Br.) H.P. Linder	1a
	Austrodanthonia racemosa (R.Br.) H.P. Linder	2e, 2f, 6a
	Austrodanthonia richardsonii (Cashmore) H.P. Linder	3a, 4a
	Austrostipa aristiglumis (F. Muell.) S.W.L. Jacobs & J. Everett	7a, 7g
	Austrostipa bigeniculata (Hughes) S.W.L. Jacobs & J. Everett	3a, f4d
	Austrostipa pubescens (R.Br.) S.W.L. Jacobs & J. Everett	2a, 2d
	Austrostipa scabra	3a, 4a
	Austrostipa setacea	1a, 4b, 7a, 7c, 7g
	Austrostipa tuckeri	9a
	Bothriochloa macra	6b
	**Bromus catharticus*	9a, 9b
	Chionochloa pallida	4b

Family	**Taxon**	**Community**
Poaceae cont.	*Cleistochloa rigida*	3a, 5a, 6b, 7c, 7d, 7g, 9a, 9b
	Cymbopogon obtectus	5a, 7a, 7g, 8a
	Cymbopogon refractus	2d, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 8a, 9a
	Cynodon dactylon	1b, 8a, 9a
	Deyeuxia mckiei	7f
	Dichanthium setosum	6b
	Dichelachne micrantha	2d, 4b, 4c, 7a, 7c, 7g, 7h
	Dichelachne rara	2d
	Dichelachne sieberiana	7e, 7f
	Digitaria breviglumis	1a, 1b, 1c, 2b, 2d, 2f, 3a, 4a, 4b, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a
	Digitaria brownii	5a, 6a, 6b, 7g
	Digitaria longiflora	2d
	Echinopogon caespitosus	1a, 1b, 2a, 2d, 4b, 6a, 7a, 7g, 9a, 9b
	Echinopogon ovatus	2d, 4a, 4b, 7a, 7d, 7g
	Enneapogon nigricans	6a, 6b
	Entolasia stricta	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 3a, 4a, 4b, 4c, 5a, 5b, 6a, 6b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a, 9b
	Eragrostis benthamii	4a
	Eragrostis brownii	2c, 4a, 4b, 5a, 6a, 6b, 7a, 7f, 7g, 9a, 9b
	Eragrostis elongata	2d, 4b, 7a, 7d, 7g, 8a
	Eragrostis leptostachya	2b, 2d, 2f, 4b, 5a, 5b, 7d, 7g, 8a
	Eragrostis mollybdea	7e
	Eragrostis tenuifolia	1a, 1c
	Eulalia aurea	7g, 8a, 9b
	Imperata cylindrica	2d, 7g
	**Lolium multiflorum*	1c
	Microlaena stipoides	1a, 1b, 2d, 6a, 6b, 7a, 7d, 7e, 7f, 7g, 9b
	Panicum effusum	1c, 2c, 2e
	**Panicum miliaceum*	6a, 6b, 9b
	Panicum simile	5b, 7g
	Paspalidium constrictum	1a, 1c, 2a, 2b, 2d, 3a, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7c, 7e, 7g, 7h, 8a, 9a, 9b

Family	Taxon	Community
Poaceae cont.	*Paspalum distchum*	1c
	Poa fax	6b, 7g
	Poa labillardieri	2d
	Poa sieberiana	1a, 1b, 1c, 2a, 2c, 2d, 2e, 3a, 4a, 4b, 7a, 7b, 7c, 7f, 7g, 7h, 9a
	**Setaria verticillata*	2e, 9a
	Sporobolus creber	7d, 7f, 8a
	Tetrarrhena juncea	2a, 2e, 3a
	Themeda australis	2a, 2b, 2d, 2e, 3a, 6b, 7f
	Thonandia longifolia (R.Br.) H.P. Linder	2e, 4b
	Triodia scariosa	5a, 6b, 7d
	Tripogon loliiformis	1c, 2d, 2f, 3a, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 8a, 9a, 9b
Polygalaceae	*Comesperma ericinum*	1a, 2a, 3a
	Comesperma sylvestre	2c
Polygonaceae	**Acetosella vulgaris*	1b, 1c
	Muehlenbeckia costata m.s.	1a, 1b, 2a, 2d, 2e, 2f
	Muehlenbeckia rhyticarya	2a
	Rumex brownii	7e, 7f, 7g ,7h, 9b
Polypodiaceae	*Platycerium bifurcatum*	2a, 2d, 7a
	Pyrrosia confluens	2a
	Pyrrosia rupestris	1a, 1b, 1c, 2a, 2c, 2d, 2f, 7a
Portulacaceae	*Calandrinia eremaea*	1b, 2e, 3a, 4b, 4c, 6b, 7a, 7c, 7e, 7f, 7g, 7h, 9a
	Calandrinia pickeringii	2d, 2e, 2f, 4a
	Calandrinia sp.	1c
	Portulaca bicolor	1b, 1c, 5a, 6a, 6b, 7a, 7d, 7f, 7g, 8a, 9a, 9b
	Portulaca filifolia	6b, 7d, 8a, 9b
	Portulaca oleracea	6a, 9b
Primulaceae	**Anagallis arvensis*	6a, 6b, 7e, 7g
Proteaceae	*Banksia integrifolia* subsp. A	1c, 2c
	Banksia spinulosa. var. *collina*	1a, 1b, 1c, 2a, 2e, 3a
	Grevillea acerata	3a
	Grevillea floribunda	5a, 5b
	Grevillea linearifolia	4b

Family	Taxon	Community
Proteaceae cont.	*Grevillea mucronulata*	3a
	Grevillea ramosissima	7c
	Grevillea triternata	5a, 5b
	Hakea dactyloides	1a, 1b, 1c, 2a, 2b, 2d, 3a, 5a, 5b, 7e
	Hakea decurrens	5b
	Hakea eriantha	2d
	Hakea macrorrhyncha W.R. Barker	3a, 4b
	Isopogon petiolaris	3a, 5a, 5b
	Lomatia fraseri	1a, 1b
	Lomatia silaifolia	1a, 1c, 2a, 2d, 2e
	Persoonia cornifolia	1a, 1b, 1c, 2a, 2d, 2e, 2f, 3a, 4b, 4c, 5a, 7a, 7b, 7c, 7d, 7e, 7g, 7h, 9a, 9b
	Persoonia oleoides	1b, 2a, 2d
	Persoonia rufa	2a, 2b, 3a
	Persoonia sericea	5a, 5b
	Persoonia tenuifolia	2d
	Persoonia terminalis subsp. *recurva*	5b
	Persoonia terminalis subsp. *terminalis*	4b, 4c, 5b
	Petrophile canescens	2d, 2e, 3a
Ranunculaceae	*Clematis glycinoides*	6b, 7g
	Ranunculus lappaceus	2d
	Ranunculus sessiliflorus	6b, 7g, 9a
Restionaceae	*Empodisma minus*	1b, 1c, 2a, 2b, 3a
	Lepyrodia anarthria	3a
	Lepyrodia leptocaulis	2a, 3a, 4a, 7c
	Lepyrodia scariosa	3a, 4b
	Restio fimbriatus	1a
Rhamnaceae	*Alphitonia excelsa*	6a, 7a, 8a
	Cryptandra amara subsp. *amara*	9a
	Cryptandra amara subsp. *floribunda*	1b, 1c, 4b, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 9a, 9b
	Cryptandra lanosiflora	1b, 1c, 3a, 4a
	Pomaderris andromedifolia	2a, 2b, 8a
	Pomaderris lanigera	2e

Family	**Taxon**	**Community**
Rhamnaceae cont.	*Pomaderris nitidula*	1c
	Pomaderris notata	2d
Rosaceae	*Acaena novae-zelandiae*	7g
	**Rosa rubiginosa*	7g
	Rubus fruticosus	7g, 9b
	Rubus parvifolius	7a, 7e
Rubiaceae	*Canthium odoratum*	6a, 7a, 7d, 7g
	Galium gaudichaudii	8a
	Galium migrans	6b, 7a, 7b, 7g, 7h
	Opercularia aspera	1a, 7d, 7g
	Opercularia hispida	1a, 2c, 4b, 5b, 7d, 7f, 7g, 9a
	Pomax umbellata	1a, 1c, 2d, 2f, 3a, 4a, 4b, 4c, 5a, 5b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 9a, 9b
Rutaceae	*Boronia algida*	1c, 3a, 4b
	Boronia amabilis	2d
	Boronia anemonifolia	1a, 1c, 2b, 7a
	Boronia anethifolia	1b, 2a, 3a, 4a, 4c, 5a, 7e, 7f
	Boronia granitica	4b, 4c, 5a, 7e, 9a
	Boronia microphylla	3a, 4b
	Boronia boliviensis m.s.	4a
	Correa reflexa	1a, 2a, 2b, 6b, 7e, 7f, 7g, 7h, 8a
	Eriostemon australasius	3a
	Eriostemon myoporoides subsp. *conduplicatus*	4b, 5a, 9a, 9b
	Eriostemon myoporoides subsp. *epilosus*	1b, 2a, 2d, 2e, 2f, 4a, 7a
	Phebalium ambiens	1a, 2d, 2e, 2f, 4b
	Phebalium dentatum	2b, 3a
	Phebalium glandulosum	4b
	Phebalium ozothamnoides F. Muell.	1a
	Phebalium rotundifolium	2d, 2f, 4b, 4c, 5a, 5b, 9a
	Phebalium squamulosum	2a, 2d, 2f, 3a, 4b, 4c, 7d
	Zieria cytisoides	1c, 2b, 6b, 7a, 7b, 7f
	Zieria fraseri	1a, 1c, 3a, 4a, 5a, 7a, 7e
	Zieria laevigata	1a, 1b, 4b
	Zieria odorifera m.s.	5a, 7a, 7c, 9a, 9b

Family	**Taxon**	**Community**
Santalaceae	*Choretrum candollei*	2a
	Choretrum sp. A	3a
	Exocarpus cupressiformis	1a, 1c, 2a, 2b, 2d, 2e, 2f, 4a, 4b, 7a, 7e, 7f, 7g
	Exocarpus strictus	2a
Sapindaceae	*Dodonaea boroniifolia*	5b, 7g
	Dodonaea falcata	5b
	Dodonaea hirsuta	2d, 4b, 5a
	Dodonaea stenophylla	9a
	Dodonaea triquetra	7d, 7g
	Dodonaea viscosa	1a, 1b, 1c, 2d, 2e, 2f, 4b, 5a, 5b, 6b, 7a, 7b, 7c, 7e, 7f, 7g
Schizaeaceae	*Schizaea bifida*	2a, 2e
Scrophulariaceae	**Gratiola peruviana*	6a, 8a
	**Verbascum thapsus*	7g
	Veronica calycina	2d, 7g, 7h
Sinopteridaceae	*Cheilanthes distans*	2d, 6a, 6b, 7d, 7f, 7g, 8a, f4b, f5a, f5b
	Cheilanthes sieberi subsp. *sieberi*	1a, 1b, 1c, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, 8a, 9a, 9b
	Pellaea falcata var. *falcata*	1a, 7g
Smilaceae	*Smilax australis*	1b, 2a, 3a
	Smilax glyciphylla	2a
Solanaceae	*Cyphanthera albicans* subsp. *albicans*	1c
	**Datura stamonium*	8a
	Solanum campanulatum	2d
	Solanum cinereum	2d, 6b, 9b
	Solanum elegans	2d
	Solanum opacum	1a, 7e, 9b
Stackhousiaceae	*Stackhousia monogyna*	1a, 2d
	Stackhousia muricata	2d
	Stackhousia viminea	1a, 1b, 1c, 2b, 2d, 2e, 4a, 4b, 6a, 7e, 9a
Sterculiaceae	*Brachychiton populneus*	6b
	Lasiopetalum ferrugineum var. *cordatum*	1b
Stylidiaceae	*Stylidium graminifolium*	2b, 2e, 2f
	Stylidium laricifolium	2a, 2b, 2d, 2e, 2f, 3a, 4a, 4b, 8a

Family	**Taxon**	**Community**
Thymelaeaceae	*Pimelea linifolia*	1a, 1b, 1c, 2a, 2d, 2e, 2f, 3a, 5a, 5b, 7a, 7d, 7g
Urticaceae	*Urtica incisa*	7e, 7g, 7h, 8a, 9b
Verbenaceae	**Verbena bonariensis*	2d
	**Verbena rigida*	7g
Violaceae	*Hybanthus monopetalus*	1b, 5a
	Viola betonicifolia	2d
	Viola hederacea	2d, 4b
Viscaceae	*Notothixos cornifolius*	6b
Winteraceae	*Tasmannia glaucifolia*	1a
	Tasmannia stipitata	2c
Xanthorrhoeaceae	*Xanthorrhoea acaulis*	3a, 7c
	Xanthorrhoea glauca	1a, 2a, 3a
	Xanthorrhoea johnsonii	2d, 4b, 5a, 5b, 7a, 7d, 7g, 8a

The vegetation of a mesa plateau in central Queensland

R.J. Fensham and J.E. Holman

Fensham, R.J. and Holman, J.E. (Queensland Herbarium, Department of Environment, Meiers Road, Indooroopilly, Queensland, Australia 4068) 1998. The vegetation of a mesa plateau in central Queensland. Cunninghamia *5(3) 619–631.* The vegetation of a trachyte-capped, basalt mesa inaccessible to stock in central Queensland (22°40'S 148°01'E; 730 m altitude) is described by quadrat survey and floristic classification of that data. Three vegetation types are recognised: a rock pavement complex; grassland (or *Eucalyptus exserta* woodland) most frequently dominated by *Themeda triandra* on rises and mid-slopes; and *Eucalyptus microcarpa* woodland in depressions. The total flora consisted of 200 species of which 26 are restricted to small pockets of rainforest. Eleven of the species are of exotic origin, of which *Melinis repens* is particularly abundant in the grassy areas. Rare species are restricted to specialised habitat on the plateau surface. However, species such as *Themeda triandra* that are sensitive to grazing may be abundant because of the absence of stock. Despite extensive ground disturbance by pigs, Lords Table Mountain has high conservation value because of its unique combinations of vegetation and geology and refugia for species that may have been reduced in abundance in the surrounding landscape due to heavy grazing by domestic stock.

Introduction

The vegetation of central Queensland has been broadly described as part of land system mapping studies (Pedley 1967; Story 1967; Speck 1968). These works provide detail for the widespread ecosystems that have most potential for animal production, including the pastures of natural grasslands and woodlands. Very few areas of grassy vegetation in eastern Australia have never been grazed by domestic stock. Fensham and Skull (in press) described tropical woodlands enclosed by lava at the Great Basalt Wall in north Queensland that prohibit the entry of cattle. They demonstrated that one perennial grass *Capillipedium parviflorum* was a dominant where stock had been absent and was not recorded in stocked areas. However, no species were considered rare or endangered in the stock-free woodlands at the Great Basalt Wall.

The plateau of the mesa Lords Table Mountain in central Queensland (22°40'S 148°01'E; 730 m altitude) supports grassy ecosystems, but is inaccessible to domestic stock because of steep cliffs (Fig. 1). It is almost certainly one of the few areas of grassy vegetation on mainland Queensland that has never been exposed to cattle or sheep. Unlike the Great Basalt Wall, and some mesa complexes in North America (Rummell 1951; Madany and West 1983), there are no opportunities for comparison with grazed similar habitat. This paper describes the vegetation of the plateau at Lords Table Mountain and discusses features of its character in relation to other vegetation types of the region and its isolation from stock.

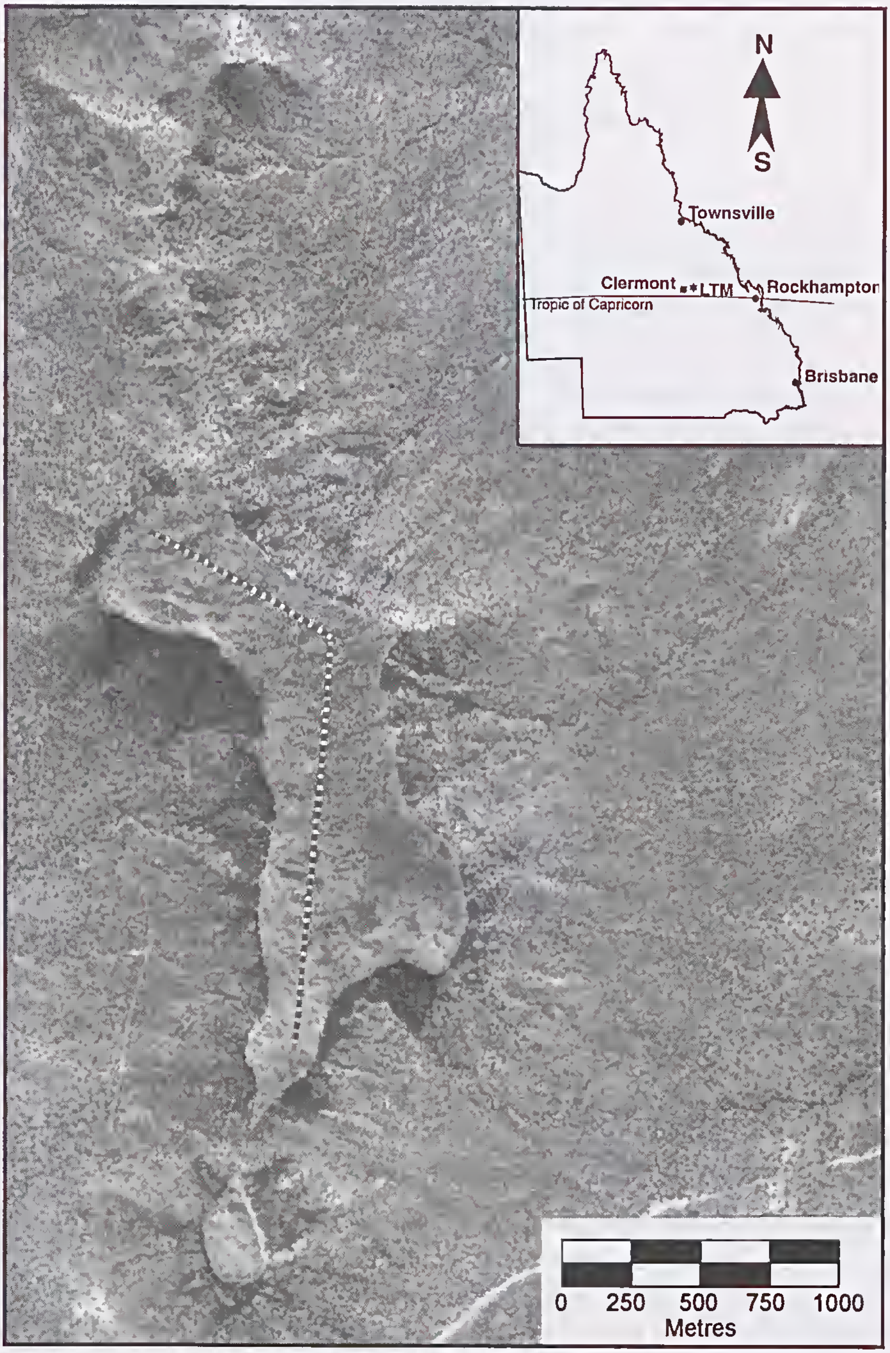

Fig. 1. Locality of Lords Table Mountain and aerial photograph of the plateau and surrounds. The location of the transect is marked. The rock pavement complex (UPGMA group 1) is not mappable at the scale of this figure. The rock pavement complex and the grassland/*Eucalyptus exserta* woodland (UPGMA group 2) comprise the light grey tone covering the majority of the area of the plateau. *Eucalyptus microcarpa* woodland (UPGMA group 3) associated with drainage depressions is distinguishable as the dark grey east-west banded pattern on the plateau surface. The dark mottled tone on the scree slopes adjoining the mesa represents dry rainforest.

Study area

Lords Table Mountain is 85 km north of the Tropic of Capricorn, 45 km ENE of Clermont (Fig. 1). It is the main feature of the Lords Table Mountain section (761 ha) of the Peak Range National Park. Mean annual rainfall at Clermont is 671 mm and is moderately seasonal with a coefficient of variation of 64.6%, with most rain falling between December and February. It lies within the Brigalow Belt North biogeographic region (Thackway & Creswell 1995).

Lords Table Mountain is a basalt mesa elevated about 320 m above the surrounding country with a plateau surface capped by trachyte covering about 140 ha (Fig. 1). The trachyte cap has provided resistance against erosion allowing this isolated mesa to survive as a rare testament to the former depth of Tertiary basalt in the district (Galloway 1967). The plateau has low relief but is intersected by shallow depressions that rapidly drain water to the east and west after rain.

The scree slopes of the plateau provide habitat for fire sensitive dry rainforest included in the survey of Fensham (1995). The basaltic foot-slopes surrounding the mesa are clothed by *Eucalyptus orgadophila* grassy woodland. While domestic stock cannot access the plateau, the presence of pigs was verified by their scratchings and common wallaroos were seen. Deer, goats or rabbits are not abundant in the region and no dung or other signs of these animals were evident.

Methods

Field methods

Sampling was conducted during April 1997 when the herbaceous flora is most easily identified. Inspection of aerial photography suggested that a transect would adequately sample the vegetation pattern and was chosen to avoid *a priori* assessment. A single transect was positioned through the middle of the long axis of the plateau (Fig. 1) and data were collected from 45 7 m × 7 m quadrats spaced at 50 m intervals.

The following data were recorded from each quadrat: a) vascular plant species present (nomenclature follows Henderson 1997) assigned to three abundance categories (1: $\leq$ 10 individuals; 2: $>$ 10 but $\leq$ 100 individuals; 3: $>$ 100 individuals); b) the diameter at breast height of all trees and shrubs greater than 2 m high; c) an estimate of crown cover of trees greater than 2 m high (%); d) an estimate of shrub cover (%); e) an estimate of herbaceous cover (%); f) cover of rock (%) measured along the perimeter of the quadrat; g) slope (°) measured with a clinometer; h) topographic position (rise, mid-slope, depression); i) number of pig scratchings.

An additional list was made of plant species not encountered within the quadrats and voucher specimens of most species were lodged at the Queensland Herbarium. Three soil samples from the range of perceived environments were taken along the transect at 1–5 cm depth.

Analytical methods

Data were stored and manipulated by the DECODA software (Minchin 1990). The floristic data from 45 quadrats were classified using UPGMA, a widely used polythetic, agglomerative procedure. Exploratory classifications using presence-absence data were compared with those using abundance data, at a variety of hierarchical levels, by ANOVA of the environmental variables of the generated groups. The final result was selected on the basis of its effective statistical representation and agreement with the authors' perception of vegetation pattern. The environmental variables according to the groups constituting the accepted final classification and the evaluation of differences using ANOVA is presented. The association of the groups in relation to topographic position was tested using a chi-squared test.

The pH of the soil samples was determined using a TPS meter (TPS Pty Ltd, Brisbane) and compared with unpublished data collected during a survey of the surrounding basalt landscape conducted by the senior author.

Results

A total of 200 species from 61 families was recorded on the plateau (Appendix 1). This total included 11 exotic species and 26 species that are restricted to isolated pockets of rainforest on rocky ground more representative of the vegetation of the surrounding scree slope. The orchid *Dockrillia bowmanii*, the herb *Plectranthus actites* and the shrub *Phebalium glandulosum* subsp. *eglandulosum* were restricted to the cliff tops. One hundred and forty five species were located in the quadrats.

The pH of the three soil samples from the trachyte mesa plateau ranged between 5.8 and 6.6, which is lower than the soil pH of *Eucalyptus orgadophila* woodland (mean value: 7.1; standard deviation 0.4; n=23) or grassland (mean value 7.2; standard deviation 0.4; n=78) on basaltic soils in the district.

The exploratory analysis indicated that a presence-absence classification at the three group level could be most powerfully confirmed by environmental differences and had the greatest conformity to our perception of vegetation-environment pattern. The first split of the dendrogram divided group 3 from the remainder of sites at a Bray-Curtis dissimilarity level of 0.92 and the second split divided groups 1 and 2 at a Bray-Curtis dissimilarity level of 0.69. The environmental relations of the flora are presented in Tables 1 and 2 and the percentage frequency association of the flora according to classificatory group in Appendix 1. The most salient features of these results are included in the following descriptions. Pig scratching was not significantly different between groups and had a mean density of 167 ha^{-1} overall.

UPGMA group 1 sites are associated with rock pavements on the rises and mid-slopes of the plateau. The pavements are habitat for a suite of annuals, including *Ipomoea polymorpha* and *Tripogon loliiformis*, and resurrection ferns, *Cheilanthes distans* and *Cheilanthes sieberi* subsp. *sieberi*, and can include the succulents *Grahamia australiana*, *Portulaca bicolor* and *Portulaca filifolia* which are largely restricted to this group. The sampling strategy ensured that these limited habitats were rarely sampled in isolation

Table 1. Mean (and standard error) of variables according to UPGMA classificatory group evaluated by one way ANOVA. Means not significantly different according to Tukey's test are annotated with the same letter.

Variable	UPGMA 1	UPGMA 2	UPGMA 3	F value
Slope (°)	2.8^{AB}	3.5^{A}	0.8^{B}	3.4*
	(0.6)	(0.8)	(0.4)	
Base rock (%)$^{+}$	8.6^{A}	2.7^{B}	0.00^{B}	9.8***
	(3.1)	(1.2)	(0.00)	
Pig scratches (49 m^{-2})	1.1^{A}	0.3^{A}	1.4^{A}	NS
	(0.5)	(0.1)	(0.4)	
Grass projective foliage cover (%)	52.2^{AB}	66.7^{A}	39.8^{A}	5.6**
	(4.3)	(1.2)	(7.9)	
Shrub canopy cover (%)$^{+}$	2.1^{A}	4.7^{A}	1.8^{A}	NS
	(0.9)	(1.2)	(0.6)	
Tree canopy cover (%)	4.0^{A}	14.9^{A}	28.5^{C}	16.9***
	(1.3)	(3.4)	(3.0)	
Eucalyptus microcarpa basal area (m^{2}.49 m^{-2})$^{+}$	0.003^{A}	0.014^{A}	0.093^{B}	12.2***
	(0.003)	(0.008)	(0.031)	
Eucalyptus exserta basal area (m^{2}.49 m^{-2})$^{+}$	0.009^{A}	0.010^{A}	0.005^{A}	NS
	(0.003)	(0.004)	(0.005)	
Rainforest basal area (m^{2}.49 m^{-2})$^{+}$	0.000^{A}	0.002^{B}	0.002^{AB}	3.5*
	(0.000)	(0.001)	(0.001)	
Other non-rainforest basal area (m^{2}.49 m^{-2})$^{+}$	0.000^{A}	0.005^{A}	0.000^{A}	NS
	(0.000)	(0.005)	(0.000)	
Total species richness (49 m^{-2})	31.1^{AB}	33.7^{A}	28.2^{B}	NS
	(1.4)	(1.2)	(2.0)	
Native species richness (49 m^{-2})	29.1^{AB}	31.4^{A}	25.3^{B}	4.3*
	(1.4)	(1.1)	(1.8)	
Exotic species richness (49 m^{-2})	2.0^{A}	2.3^{A}	2.9^{A}	NS
	(0.2)	(0.2)	(0.4)	
n	17	18	10	

$^{+}$ Transformed using $\log_e(x+1)$

* $0.01 < P < 0.05$; ** $0.001 < P < 0.01$; *** $P < 0.001$

Table 2. Association of UPGMA classificatory groups with topographic position (Chi-square = 12.7; D.F. = 4; P < 0.025).

	UPGMA 1	UPGMA 2	UPGMA 3	Total
Rise	9	7	1	17
Mid-slope	7	6	5	18
Depression	2	1	7	10
Total	18	14	13	45

from surrounding grassland on relatively deep soil, so the classification found definition in the presence of these indicators rather than the absence of other species more akin to group 2.

UPGMA group 2 represents the grassland–low woodland (dominated by *Eucalyptus exserta*) that dominates the plateau on mid-slopes and rises that are less rocky than UPGMA group 1 (Fig. 2). The dominant grasses according to a scale of frequency of sites (n = 18) where they have an abundance rating of three are *Themeda triandra* (15), *Melinis repens* (10) and *Heteropogon contortus* (9). *Themeda triandra* is the same taxon as *Themeda australis* in NSW. The grasslands comprising this group are relatively species rich compared to the other groups. The grasses *Aristida queenslandica* var. *dissimilis*, *Bothriochloa ewartiana* and *Panicum effusum* are indicators of the group.

UPGMA group 3 sites are woodland dominated by *Eucalyptus microcarpa* that occurs in the depressions (Figs 1 and 3). Other faithful indicators of this group include the tree *Notelaea microcarpa*, the grasses *Bothriochloa decipiens* and *Panicum decompositum* var. *tenuius*, and the herbs *Sigesbeckia orientalis* and *Vernonia cinerea*. Projective foliage cover of grass is the lowest of all groups.

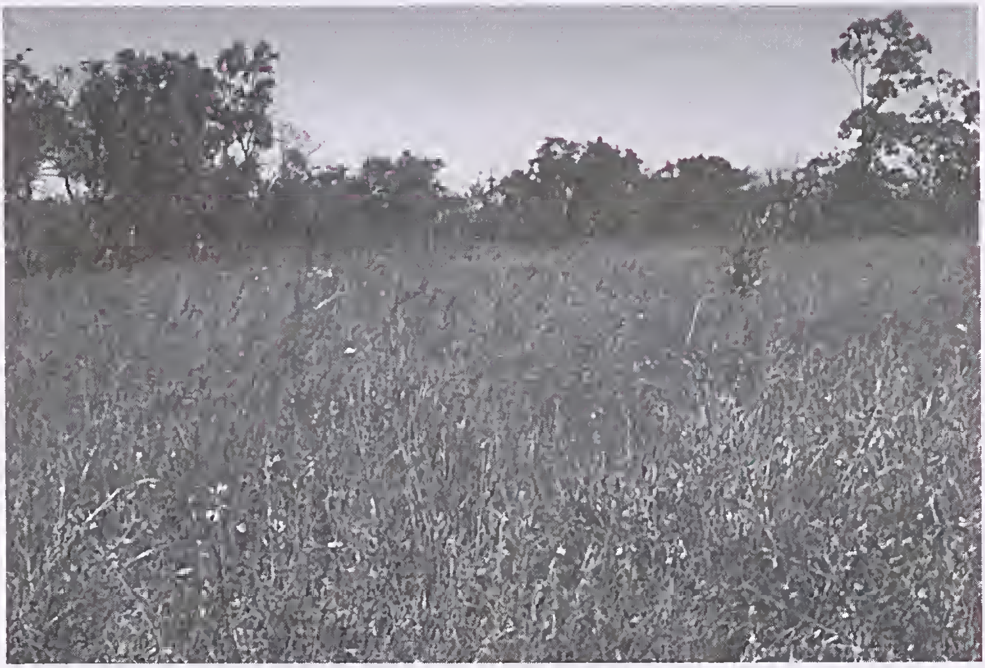

Fig. 2. Grassland dominated by *Themeda triandra* represented as UPGMA group 2 by the classification.

Discussion

Regional context

The soils on trachyte at Lords Table Mountain have lower pH values than the soils on basalt in the region. Grasslands and grassy woodlands on basalt are widespread in the region although grasslands on trachyte have not previously been recorded in the literature. The natural grass dominant of the grasslands on the basalt landscapes in the region is *Dichanthium sericeum* (Oxford land system). Grassland dominated by *Themeda triandra* has not previously been described for the Brigalow Belt North biogeographic region, although it does occur on the south-eastern edge of the Brigalow Belt South region at the Bunya Mountains (Fensham & Fairfax 1996). It does not appear that *Themeda triandra* was the natural dominant of other grasslands used as pasture in the region because it scarcely occurs on the heavy clay soils that support *Dichanthium sericeum* grassland and is still common in woodland lightly grazed by domestic stock.

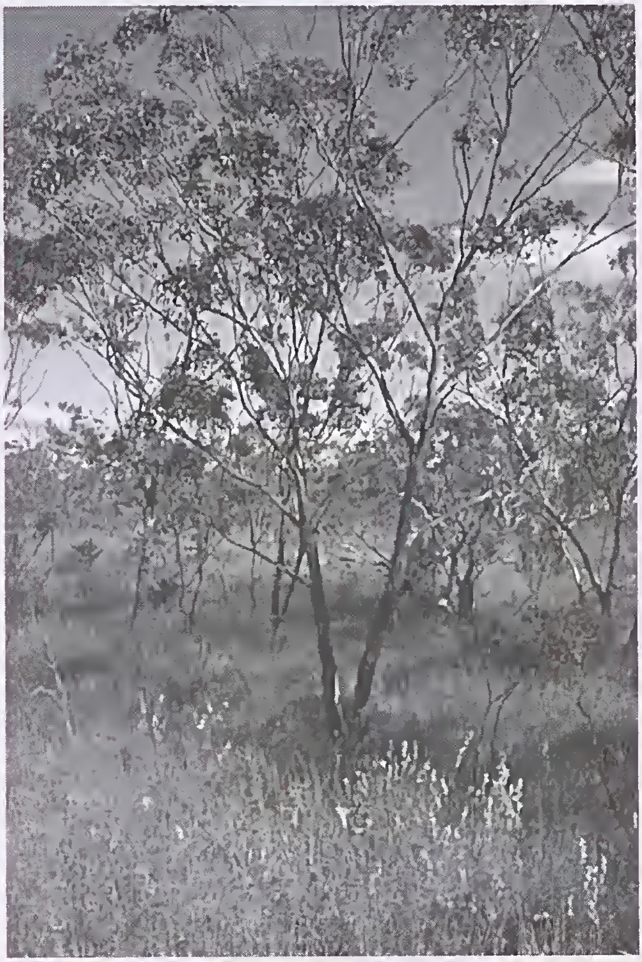

Fig. 3. Woodland dominated by *Eucalyptus microcarpa* in drainage depression represented as UPGMA group 3 by the classification.

Eucalyptus microcarpa dominates forest and woodland in southern Queensland, but the stands on Lords Table Mountain are isolated from the main distribution of the species. Texture contrast soils with acidic sub-soils provide typical habitat for *Eucalyptus microcarpa* (Land unit 28, Galloway et al. 1974) forest and woodland in southern Queensland and for similar formations dominated by its close ally *Eucalyptus moluccana* in the coastal and sub-coastal parts of both the Brigalow Belt North and South biogeographic regions (Brooker & Kleinig 1994). Vegetation dominated by either of these species occurring on igneous rocks has not previously been described (Story et al. 1967; Speck et al. 1968; Galloway et al. 1974).

Distinctive flora

The Queensland Herbarium database HERBRECS was used to search for species collected on Lords Table Mountain that may be rare in the region. The recently described *Plectranthus actites* is only known from this site (Forster 1994). The taxonomic status of *Callistemon* sp. (Ropers Peak, *P.I. Forster PIF7208*) is uncertain, but it may be restricted to range country in central Queensland. The graminaceous fern *Isoetes muelleri* and the succulent *Grahamia australiana* are the only species, recorded outside the rainforest or cliff-top habitats, that may be rare within the region. *Isoetes* is an ephemeral that appears only briefly after rain and may in fact be rare in time rather than space. Both *Isoetes* and *Grahamia* are restricted to specialised habitats, rocky depressions and rock pavements respectively.

There were no species at Lords Table Mountain abundant in the stock-free vegetation, but largely eradicated from the grazed landscape, i.e. equivalent to *Capillipedium* at the Great Basalt Wall. However, relative species abundances have undoubtedly been altered as a result of heavy total grazing pressure. The known grazing sensitivity of *Themeda triandra* (McIvor & Scanlan 1994) and its dominance in the herbaceous understoreys of UPGMA group 2 is suggestive of light grazing by native herbivores on Lords Table Mountain.

The total number of exotics (5.5% of species) recorded at Lords Table Mountain was relatively small, but the second most abundant species in the grassy understoreys was the southern African grass *Melinis repens*. The plumed seed of the species provides effective dispersal and pig scratching may provide the bare ground that favours the establishment of this species. Fensham and Skull (in press) demonstrated that *Melinis repens* was favoured in the cattle-free woodland at the Great Basalt Wall. This result together with its abundance at Lords Table Mountain suggest that it may be sensitive to grazing despite having low productive value as a mature plant (Tothill & Hacker 1973).

Lords Table Mountain includes combinations of vegetation and geology that are probably absent elsewhere in the region. It is further unique because it is ungrazed by domestic stock, although the ground is extensively disturbed by pigs. The mesa has high conservation value and the plateau and its surrounds are a valuable asset within Queensland's National Park estate.

Acknowledgments

Peter Barton provided the directions to access the plateau top and allowed us to camp on his land. Melinda Cox and Juliana McCosker are thanked for field assistance. John Burgess was the source of instructuve discussions regarding geology, and Tony Bean, Gordon Guymer and the reviewers provided useful comments on the manuscript. This project was partly funded by the Grassland Ecology Program, ANCA.

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Manuscript accepted 9 March 1998

Appendix 1 Percentage frequency of species according to UPGMA classificatory group. Species recorded from the plateau top, but not within quadrats are included without frequency values. Nomenclature follows that accepted at Queensland Herbarium.

	UPGMA group		
	1	2	3
PTERIOPHYTA			
Isoetaceae			
Isoetes muelleri			
Ophioglossaceae			
Ophioglossum gramineum			
Sinopteridaceae			
Cheilanthes distans	94.1	11.1	10.0
Cheilanthes sieberi subsp *sieberi*	88.2	33.3	-
Doryopteris concolor	5.9	-	-
ANGIOSPERMEAE			
Acanthaceae			
Brunoniella australis	5.9	77.8	90.0
Pseuderanthenum variabile	-	-	20.0
Amaranthaceae			
Achyranthes aspera			
Alternanthera denticulata	-	-	40.0
Alternanthera nana	5.9	-	10.0
Anacardiaceae			
Euroschinus falcata	5.9	11.1	-
Apocynaceae			
Alstonia constricta	-	11.1	-
Alyxia ruscifolia	11.8	16.7	10.0
Carissa ovata	-	5.6	-
Parsonsia lanceolata[2]			
Parsonsia plaesiophylla[2]			
Araliaceae			
Polyscias elegans[2]			
Asclepiadaceae			
Hoya australis[2]			
Marsdenia microlepis	5.9	11.1	20.0
Marsdenia viridiflora	-	-	20.0
Secamone elliptica	5.9	5.6	20.0
Asteraceae			
Acmella grandiflora var. *brachyglossa*	-	-	30.0
Bidens bipinnata[1]	17.7	55.6	50.0
Brachyscome microcarpa	5.9	-	-
Bracteantha bracteata	47.1	38.9	-
Chrysocephalum apiculatum			

	UPGMA group		
	1	2	3
Epaltes australis			
Glossocardia bidens	5.9	-	-
Parthenium hysterophorus[1]	5.9	11.1	20.0
Peripleura hispidula subsp. *hispidula*	88.2	44.4	-
Ptercaulon sphacelatum	-	-	10.0
Schkuria pinnata var. *abrotanoides*[1]	5.9	-	-
Sigesbeckia orientalis[1]	17.7	27.8	80.0
Tagetes minima[1]	5.9	-	-
Vernonia cinerea	11.8	16.7	60.0
Vittadinia pterochaeta	29.4	33.3	-
Vittadinia sulcata	11.8	5.6	-
Bignoniaceae			
Pandorea pandorana	5.9	5.6	-
Boraginaceae			
Heliotropium brachygyne	35.3	16.7	-
Cactaceae			
Opuntia stricta[1]	52.9	33.3	70.0
Opuntia tomentosa[1]	11.8	61.1	60.0
Caesalpiniaceae			
Chamaecrista absus	47.1	72.2	30.0
Chamaecrista mimosoides	58.8	27.8	-
Senna surratensis subsp. *retusa*			
Campanulaceae			
Lobelia quandrangularis	23.5	55.6	60.0
Wahlenbergia gracilis	88.2	55.6	-
Capparaceae			
Capparis arborea[2]			
Celastraceae			
Maytenus disperma	-	-	20.0
Clusiaceae			
Hypericum gramineum			
Commelinaceae			
Commelina cyanea	17.7	44.4	40.0
Convolvulaceae			
Dichondra repens	-	5.6	-
Evolvulus alsinoides	76.5	66.7	50.0
Ipomoea plebeia	35.3	55.6	40.0
Ipomoea polymorpha	82.4	33.3	-

	UPGMA group		
	1	2	3
Crassulaceae			
Bryophyllum tubiflorum[1]			
Cyperaceae			
Cyperus bifax	-	5.6	40.0
Cyperus conicus	-	-	10.0
Cyperus difformis			
Cyperus fulvus	-	11.1	30.0
Cyperus gracilis	-	-	30.0
Cyperus squarrosus	-	5.6	10.0
Fimbristylis dichotoma	88.2	88.9	80.0
Liphocarpha microcephala			
Scleria mackaviensis	11.8	33.3	-
Droseraceae			
Drosera indica			
Ebenaceae			
Diospyros humilis	-	-	20.0
Erythroxylaceae			
Erythroxylum australe[2]			
Euphorbiaceae			
Acalypha eremorum[2]			
Breynia oblongifolia	5.9	11.1	20.0
Briedela leichhardtii[2]			
Drypetes deplanchei[2]			
Euphorbia drummondii	-	5.6	-
Euphorbia tannensis	29.4	11.1	-
Flueggea leucopyrus	-	-	10.0
Phyllanthus virgatus	58.8	66.7	30.0
Poranthera microphylla	11.8	-	-
Fabaceae			
Crotalaria incana[1]			
Crotalaria juncea	41.2	50.0	10.0
Desmodium gunnii	-	-	10.0
Desmodium rhytidophyllum	17.7	5.6	20.0
Desmodium varians	-	5.6	-
Galactia tenuiflora	35.3	50.0	-
Glycine tabacina	11.8	33.3	10.0
Glycine tomentella	23.5	38.9	10.0
Indigastrum parviflorum	-	5.6	-
Indigofera hirsuta	5.9	11.1	-
Indigofera linnaei	17.7	11.1	10.0
Rhynchosia minima			
Tephrosia filipes	35.3	11.1	-
Zornia muriculata subsp. *muriculata*	23.5	22.2	-
Goodeniaceae			
Goodenia grandiflora			
Juncaceae			
Juncus aridicola	-	5.6	40.0
Lamiaceae			
Plectranthus actites[3]	-	16.7	-
Liliaceae			
Dianella caerulea	58.8	55.6	100.0
Hypoxis hygrometrica var. *villosisepala*	52.9	50.0	30.0
Iphigenia indica	35.3	22.2	10.0
Tricoryne elatior	11.8	5.6	-
Lythraceae			
Ammania multiflora			
Rotala mexicana			
Malvaceae			
Abutilon oxycarpum var. *oxycarpum*			
Hibiscus sturtii	5.9	16.7	-
Hibiscus trionum	11.8	-	10.0
Malvastrum americanum[1]			
Sida spinosa	-	16.7	20.0
Sida subspicata	5.9	22.2	-
Sida sp. (Greenvale R.J. Fensham 1150)[2]			
Meliaceae			
Melia adzedarach[2]			
Menispermeaceae			
Tinospora smilacina	-	-	10.0
Mimosaceae			
Acacia decora	23.5	-	-
Neptunia gracilis	-	11.1	10.0
Moraceae			
Ficus obliqua subsp.*petiolaris*[2]			
Ficus opposita[2]			
Ficus virens[2]			
Myrtaceae			
Austromyrtus bidwillii[2]			
Callistemon sp. (Ropers Peak, P.I. Forster PIF7208)	-	16.7	20.0
Eucalyptus exserta	47.1	67.7	30.0
Eucalyptus microtheca	23.5	27.8	100.0
Oleaceae			
Jasminum didymum[2]			

	UPGMA group		
	1	2	3
Jasminum simplicifolium			
Notelaea microcarpa	11.8	33.3	90.0
Orchidaceae			
Dockrillia bowmanii[3]			
Oxalidaceae			
Oxalis corniculata	58.8	55.6	20.0
Pittosporaceae			
Citriobatus spinescens	-	22.2	-
Poaceae			
Alloteropsis cimicina	29.4	22.2	-
Ancistrachne uncinulata[2]			
Aristida calycina var. *calycina*	5.9	-	-
Aristida latifolia	-	-	20.0
Aristida lazaridis	11.8	50.0	10.0
Aristida leptopoda	-	-	10.0
Aristida muricata	23.5	5.6	-
Aristida queenslandica var. *dissimilis*	29.4	61.1	30.0
Aristida ramosa	-	11.1	-
Aristida spuria	52.9	5.6	-
Bothriochloa bladhii	5.9	27.8	40.0
Bothriochloa decipiens	-	27.8	70.0
Bothriochloa ewartiana	23.5	61.1	20.0
Brachiaria foliosa			
Brachiaria holosericea	17.7	5.6	-
Chloris divaricata	-	-	10.0
Chrysopogon fallax	41.2	27.8	40.0
Cymbopogon obtectus	82.4	61.1	10.0
Cymbopogon queenslandicus	11.8	-	-
Cymbopogon refractus	-	27.8	30.0
Dichanthium sericeum subsp. *humilis*	70.6	55.6	20.0
Digitaria brownii	-	33.3	40.0
Digitaria divaricatissima	11.8	27.8	-
Enneapogon gracilis	23.5	5.6	-
Enneapogon lindleyanus	29.4	50.0	-
Eragrostis elongata	-	-	20.0
Eragrostis sororia	5.9	5.6	20.0
Eriachne mucronata	5.9	-	-
Eriochloa procera	-	5.6	60.0
Eulalia aurea	5.9	-	-
Heteropogon contortus	94.1	77.8	60.0
Iseilema vaginiflorum	-	-	10.0
Leptochloa decipiens	-	-	50.0
Melinis repens[1]	100.0	94.4	60.0

	UPGMA group		
	1	2	3
Microlaena stipoides[2]			
Oplismenus aemulus[2]			
Panicum decompositum var. *tenuius*	5.93	3.37	0.0
Panicum effusum	52.9	100.0	50.0
Panicum queenslandicum	-	-	10.0
Paspalidium constrictum	41.2	66.7	30.0
Sorghum leiocladum	-	5.6	-
Sporobolus elongata	5.9	11.1	50.0
Themeda triandra	100.0	100.0	80.0
Tragus australiensis	29.4	22.2	-
Tripogon loliiformis	70.6	27.8	-
Polygalaceae			
Polygala linariifolia	41.2	55.6	20.0
Portulacaceae			
Grahamia australiana	17.7	5.6	-
Portulaca bicolor	11.8	-	-
Portulaca filifolia	17.7	-	-
Proteaceae			
Hakea lorea	5.9	-	-
Rhamnaceae			
Alphitonia excelsa			
Rubiaceae			
Canthium odoratum[2]			
Canthium sp. (Duaringa, N.H. Speck 1819)	47.1	66.7	40.0
Oldenlandia coerulescens	23.5	5.6	-
Oldenlandia galioides			
Oldenlandia mitrasacmoides subsp. *trachymenoides*			
Spermacoce sp. (R.J. Fensham 3177)	52.9	22.2	20.0
Rutaceae			
Acronychia laevis[2]			
Geijera salicfolia[2]			
Phebalium glandulosum subsp. *eglandulosum*[3]			
Santalaceae			
Exocarpos latifolius[2]			
Sapindaceae			
Alectryon connatus[2]			
Dodonaea viscosa	82.4	94.4	100.0
Sapotaceae			
Planchonella cotinifolia[2]			

	UPGMA group		
	1	2	3
Scrophulariaceae			
Stemodia glabella			
Smilacaceae			
Eustrephus latifolius	5.9	33.3	10.0
Solanaceae			
Solanum ellipticum	-	11.1	-
Sterculiaceae			
Brachychiton australis			
Brachychiton populneus	-	11.1	-
Brachychiton rupestris			
Tiliaceae			
Grewia latifolia	-	5.6	-
Verbenaceae			
Clerodendrum floribundum			
Violaceae			
Hybanthus stellarioides	35.3	33.3	10.0
Vitaceae			
Cayratia clematidea	-	11.1	-
Cissus oblonga	11.8	16.7	-
Cissus opaca[2]			
Xanthorrhoeaceae			
Lomandra longifolia	-	11.1	-

[1] exotic species

[2] restricted to rainforest habitat

[3] restricted to cliff top habitat

Wetland vegetation mapping using a Global Positioning System

Robert Payne and Chris Harty

Payne, Robert[1] *& Harty, Chris*[2] *([1]15 Mountain-Ash Way, Umina Beach, NSW 2257; [2]Corangamite Shire Council, PO Box 84 Camperdown,Victoria 3260). Wetland Vegetation Mapping using a Global Positioning System.* Cunninghamia *5(3): 633–643.* A methodology for mapping wetland vegetation of coastal wetlands within the City of Gosford, including those listed under State Environmental Planning Policy No. 14, is described. The methodology and principles, including their advantages and disadvantages, are explained. They may have further application for other large scale vegetation and fauna habitat mapping projects. The outcome of the project is seen to be important for preparing a conservation plan for the wetlands.

Introduction

Local Government plays a pivotal role in planning and controlling development within wetlands in New South Wales. Local Council is, in most cases, the decision making authority responsible for assessing and approving Development Applications and as such has responsibility for ensuring that all due consideration is made for wetland protection throughout this process.

Coastal wetlands within NSW are the subject of State Environmental Planning Policy No. 14 — 'Coastal Wetlands'. The aim of the Policy is to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the State of NSW. SEPP 14 applies to the City of Gosford, in the general vicinity of the seaboard estuarine fringe where coastal lagoons, rivers and creeks are associated with wetlands.

The Brisbane Water Area Wetland Management Study was initiated and formally adopted by Gosford City Council in September 1993. The aim of this study was to accurately map all wetland vegetation in the Gosford Local Government Area and describe the status of each site. With this information the following objectives were considered attainable.

- Establish a Priority List of sites of community value which are in Public Reserve.
- Amend the boundaries of State Environmental Planning Policy No. 14 (SEPP 14) to ensure that they accurately reflect the ecological significance of the wetlands.
- Provide base data for Development Control Plans, Local Environmental Plans and Site Specific Management Plans.
- Provide information for the assessment of developments in wetland catchments.

An initial study (Jones 1991) identified over 50 wetland sites within the Brisbane Water and estuarine area which were considered as ecosystems worthy of conservation for the following reasons.

Wetlands:

- have a limited distribution due to Australia's dry climate (Giles, 1983).
- support a unique array of native mammals, reptiles, fish, amphibians, flora and waterbirds (Giles 1983).
- are sometines of critical importance to internationally important migratory wader birds (Giles 1983).
- can provide drought refuge for native fauna (Giles 1983).
- form the basis of fish food chains (Harty 1997).
- provide for a range of recreational experiences (Harty 1997).
- act as flood retardation areas (Briggs 1983).
- filter nutrients and sediments from runoff entering waterways (Harty 1997).

In accepting the study, Gosford City Council adopted a Wetland Strategy which, amongst other things, included amending the boundaries of SEPP 14 Coastal Wetlands to ensure that they accurately reflected the ecological significance of wetland communities. Gosford City Council was also to produce a Local Environmental Plan and Wetland Management Strategy. This procedure was to ensure greater protection of wetlands and improved integrated management of wetlands into the long-term.

However, when it came to implementing the Wetland Strategy it was found that the quality and accuracy of the mapping did not provide accurate enough information for zoning purposes or to locate the boundaries of the identified wetlands on the ground and on the Planning Scheme Maps. Pressure from development, however, required a means had to be found for redefining the SEPP 14 wetland boundaries in relation to cadastral boundaries.

Standard methods for mapping vegetation and fauna habitat use aerial photography or satellite imagery combined with ground truthing. In recent years the introduction of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) have improved the potential and capability of mapping. In particular, the use of GPS has application for identifying the boundaries of sensitive habitats at large scales (Payne 1996a).

The aim of this project was to determine how accurate and efficient the use of the GPS could be applied to the wetland project. At the time the accuracy and efficiency of the GPS for mapping vegetation was uncertain because of the presence of the canopy covering the vegetation. However, a quick and efficient method with a relatively high degree of accuracy for defining wetland boundaries based upon vegetation and the degree of inundation was needed. GPS was considered to have potential, although it had not been previously trialed for wetland mapping.

The project involved over 50 wetland sites of various sizes. The methodology involved may have potential for other mapping projects, especially for defining sensitive flora and fauna habitats that may be required for identification and management under the New South Wales Threatened Species Conservation Act, 1995.

Location

State Environmental Planning Policy No. 14 (SEPP 14) applies to the City of Gosford in the general vicinity of the estuarine fringes where coastal lagoons, rivers and creeks are associated with wetlands. The Policy does not apply to the wetlands associated with the Hawkesbury River and its tributaries which are located west of the coastal escarpment but also within the City boundaries. Those areas are subject to State Regional Environmental Plan No. 20. Sydney Regional Environmental Plan No. 20 covers the Hawkesbury-Nepean River system and is a landuse planning instrument prepared under the New South Wales Environmental Planning and Assessment Act, 1979. The aim of the Regional Environmental Plan No. 20 is to protect the environment of the Hawkesbury-Nepean River System, including all of the riparian wetlands, by ensuring that the impacts of future landuses are considered in a regional context. The wetlands surveyed during this exercise incorporate all the coastal lowland areas located east of the Brisbane Water National Park and the Somersby-Kulnura Plateaus.

Methods

Most of the wetlands were initially identified by Adams et al. (1985) and then subsequently updated by Jones (1991). The database involved over 50 wetland sites and if the additional wetland sites identified by Jones (1991) were to be included the number almost doubled. Furthermore, Jones (1991) included all the Swamp Mahogany forests that have since been identified as being 'keystone' habitat for a large number of nectivorous animals and habitat for at least nine threatened species (Payne 1996b).

In both cases aerial photography was used to map the wetlands at medium to small scales (1: 16 000 and 1: 25 000). This has led to inaccuracies when used in conjunction with property boundary information. The problems considered to be issues were :

- Aerial photographs have a variable scale over every point on a photo and in general 'rectified' photos are not available.

- The identification of wetland vegetation on aerial photographs is only partially accurate and is limited by how well the structural detail of the vegetation can be seen.

- There are now extensive public reserve areas which are mown and merge into the wetlands. The identification of the remaining wetland vegetation (herbland and grassland) in these circumstances, using aerial photography, is difficult.

During 1996 GPS technology was used to revise the boundaries of all the wetlands listed under SEPP 14 within the City of Gosford. The project took twelve months to complete and involved the use of a differential GPS and the 'OmniSTAR' network system.

Two personnel were involved in the survey. A botanist was required to identify the vegetation boundary and to measure any offset distances and bearings, and a surveyor operated the GPS (Fig. 1). A portable backpack type 'Trimble' GPS coupled to the differential GPS service was used which involved the 'OmniSTAR' network system. The 'OmniSTAR' system involves a number of reference stations located throughout Australia and New Zealand which have been accurately connected to the Australian

Fiducial Network. All of these reference stations use high quality geodetic receivers which transmit GPS corrections every second to the National Control Centre (NCC) in Perth. Following rigorous quality checks, the corrections are broadcast through the Optus B1 satellite. The GPS receiver and 'OmniSTAR' demodulator are used whereby corrections to coordinates are updated every two seconds. This method can give an accuracy of ± 1 m in position as compared to true Integrated Survey Grid (ISG) coordinates as determined by McKinleyside & Bannister (1995).

The boundary of the estuarine wetland was determined as the landward limit of the SEPP 14 wetland as documented by Adam et al. (1985). This boundary was based upon plant species (vegetation) and/or the zone of inundation. For the Swamp Mahogany forest the landward limit was joined onto the SEPP 14 wetland boundary. Vegetation boundaries were then presented as a series of coordinated fixed points which on a plan are represented as a series of connected straight lines rather than curved lines.

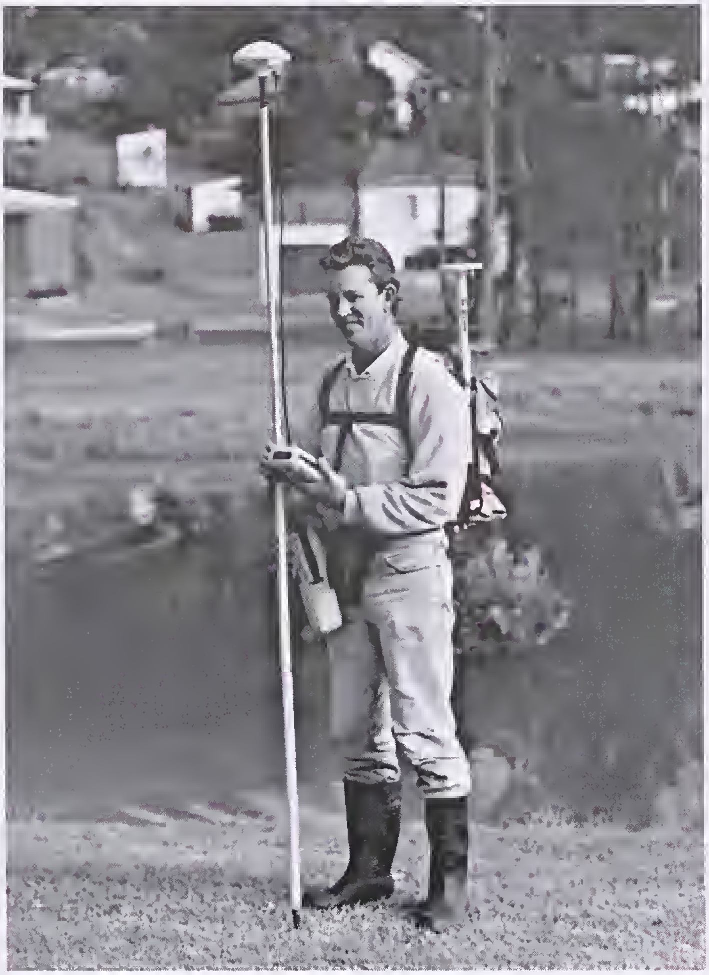

Fig. 1. Surveyor (David Gee) with GPS equipment used in the study.

The distance between coordinated points was variable and was dependent upon the changes in direction of a vegetation boundary and capability of access through the vegetation with the GPS equipment. The total distance between any two coordinated points on the boundary, however, never exceeded 100 m. Once a boundary was surveyed in the field, the coordinates were downloaded into a computer and subsequently overlaid onto the cadastral database. The resulting map product, in digital format, then has the advantage of being able to be reproduced at a number of map scales. Furthermore it is available as a set of coordinates to be further used by a surveyor to locate the wetland boundary in the field.

Results

Technological issues

The availability of satellite signals and topographic position were the two main problems encountered during the survey. Although over 30 satellites are available from which to receive signals their positions are at times not optimal to achieve a coordinate fix of sufficient accuracy. Precision Dilution of the Point (PDOP) varies over time during the day and a coordinate fix will not be achieved unless the PDOP is less than 6.0 on the vertical scale. For example, from Fig. 2 it can be seen that optimum times for signal availability at Hardys Bay on 26 February 1997 occurred between 0800 and 0930 hours and between 1045 and 1130 hours. Access to satellite signals cannot be achieved throughout all of the day, limiting the efficiency of the GPS for such projects.

The position of the wetland in relation to the topography can also be a constraint. Satellites are present in the northern hemisphere and access to signals is best achieved with the antennas having a line of sight to the northern sky. During this survey, difficulties were encountered where the escarpment and ranges blocked signal access to the northern sky even though access to the satellites was still possible in the eastern and western skies. Access to the northern sky from Hardys Bay on 26 February 1997 was blocked by the escarpment, and this also limited the time that signals were available (Fig. 2). Fig. 3 shows that at this location satellites 25, 15, 29, 14 and 16 were available in the western sky at this time. Thus prior prediction of satellite availability became extremely relevant during the project at particular locations.

Within the City of Gosford, estuarine wetland vegetation communities vary from closed herblands dominated by *Sarcocornia quinqueflora* to semi-closed forests of *Casuarina glauca*. Most importantly the vegetation varies in structural composition and as structural complexity and height of the vegetation increases, available light to the forest floor decreases. This factor has important implications with respect to accessing satellite signals and defining the wetland edge.

Access to satellite signals was achieved easily whilst surveying through the *Sarcocornia samphire* meadows and in open forest eucalypt vegetation (Swamp Mahogany forest). In the latter vegetation type, if a signal could not be achieved, it meant moving a short distance from the desired point and obtaining the signal at an offset point. In these

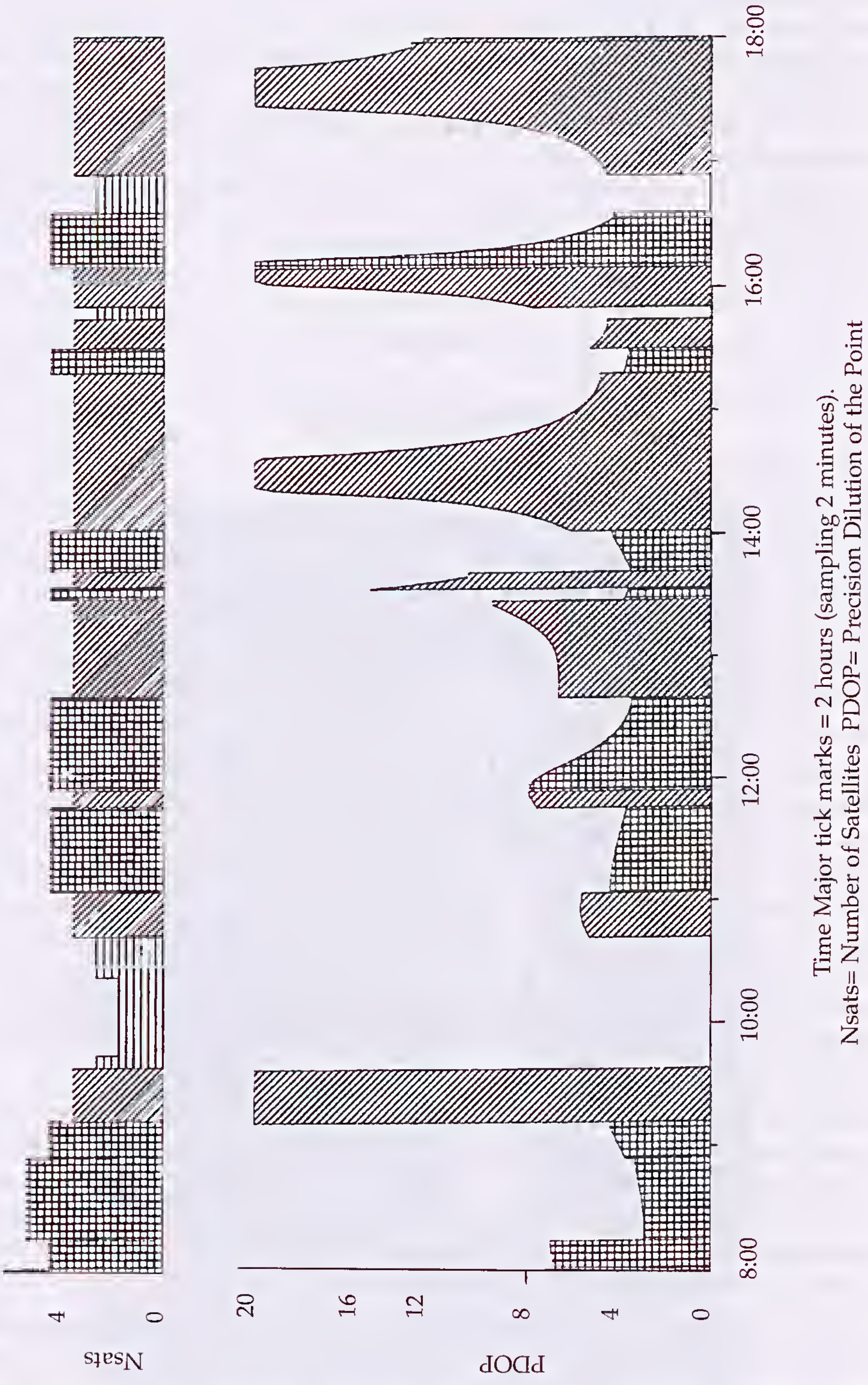

Fig. 2. Computer output from the GPS software showing both the availability of satellites and the PDOP for Wednesday 26 February 1997 at Hardys Bay. The threshold elevation was 15 degress and 27 satellites were considered.

circumstances, an offset bearing and distance was taken and entered into the GPS logger which automatically adjusted the coordinates to those of the desired point.

Some difficulty, however, was encountered beneath the forests of *Casuarina glauca*. The dense foliage of these trees blocks satellite signals. In these circumstances, substantial traversing had to be undertaken to coordinate the boundary of the vegetation. It was considered, therefore, that the boundaries derived for these forests may have a greater degree of variance using the GPS technique.

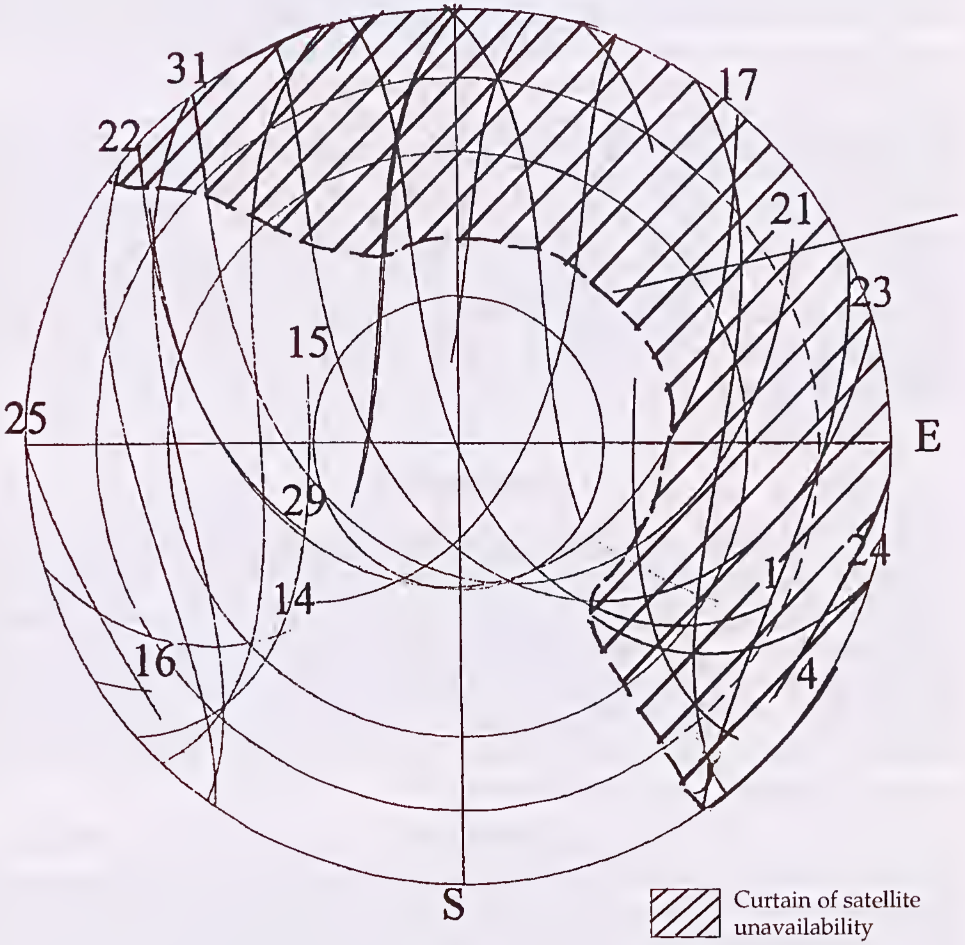

Fig. 3. Computer output from the GPS software showing the position of the satellites given certain threshold levels for the topography. The output is for Hardys Bay and shows that satellites 25, 15, 29, 14 and 16 are available in the western sky on that day. The threshold elevation was 15 degrees and 27 satellites were considered.

Vegetation

The field definition of the wetland boundary using plant species was found to be relatively easy. Dominant reeds, sedges, herbs and grasses were used as indicator species. Such species included *Selliera radicans, Schoenoplectus littoralis, Sporobolus virginicus, Cotula australis* and *Cotula coronopifolia*. Such a method has been previously outlined by Winning (1993) for the wetlands in Wyong Shire, where the following criterion was used: 'wetlands occur on lands on which non-estuarine water ponds or is capable of ponding to a depth of 0.12 metres or more, over 70% or more of its total surface area.'

The boundaries that were mapped in this study involved the foreshore fringe and Swamp Mahogany vegetation of the Brisbane Water, Narara, Kincumber and Erina Creeks and the coastal lagoons — a length in excess of 70 km. Overall the task took twelve months to complete working an average of two to three days per week. Access to the vegetation of the Brisbane Water foreshore was relatively easy because of the many pathways, tracks and boat ramps which lead into the wetlands.

The criterion developed by Winning (1993) strictly relates to those wetlands having conservation value, because many of the wetlands in Wyong are disturbed from past pastoral activities. For our survey all wetlands were remapped according to the database prepared by Jones (1991). Some wetlands could never meet the criterion of conservation value prepared by Winning (1993) and in some cases the wetlands could never meet the SEPP 14 criteria. Under these circumstances Gosford City Council still required the information on these wetlands for inclusion under a separate Local Environmental Plan.

Discussion

Our wetland boundary information will now enable Gosford City Council to prepare a Local Environmental Plan and to introduce a protective zone for wetlands. The technology has raised the standard of mapping for SEPP 14 Coastal Wetlands administered by the NSW Department of Urban Affairs and Planning and may have pioneered a new era for defining the boundaries of those coastal wetlands. The mapping system developed with the use of GPS in conjunction with GIS at an individual wetland scale (Payne & Palmer 1997) will help the protection of some unique and valuable ecosystems in the state.

Our results indicate that high orders of accuracy can be obtained for defining a vegetation boundary provided that a repeated series of coordinates is obtained at each point surveyed. As normal procedure the survey involved remaining at the desired point to be coordinated for 15 seconds (where 15 fixes were obtained and meaned) to obtain a more accurate position from the satellites. In denser vegetation the same procedure could take as long as one minute depending on the signals. As a check numerous state survey marks were coordinated during the wetland traverses and 'tied' into the vegetation boundary survey. It was found that high orders of accuracy could be obtained when a comparison was made with true Integrated Survey Grid (ISG) coordinates (e.g. ± 1.5 m).

Mapping vegetation using GPS avoids digitising a line on a map for the boundary. The coordinates obtained for each point in the field are downloaded directly into the computer and reproduced as a set of points on a map with a grid and with the cadastral database if desired. The method is very efficient and only requires the points to be joined by a straight line in the computer. A disadvantage is that the boundary becomes a series of straight lines whereas in conventional GIS mapping a curved line traced from an aerial photograph can be digitised as the vegetation boundary.

The GPS technique can be time-consuming due to satellite unavailability at certain times. However, it does have the advantage of being accurate and it is certainly accurate enough to define a vegetation boundary. Our experience has shown that orders of accuracy of ± 1.5 m are obtainable in ideal circumstances. The method revealed that some boundaries shown by the earlier methodology prepared by the Department of Urban Affairs and Planning (Adam et al. 1985) are in error by up to 50 m in position, for example Terrigal Lagoon (Fig. 4).

Accuracy of locating a wetland vegetation boundary is important particularly where private property developments are concerned. Gosford City Council, as a result of this exercise, will now be anticipating an update of the SEPP 14 boundaries through the Department of Urban Affairs and Planning both on their mapping GIS system and on the ground. Council will also be able to establish appropriate protective zonings for all coastal wetlands (not just SEPP 14) using either a 7(g) Wetlands Management Zone or the 7(a) Conservation Zone under a Local Environmental Plan. Council will also be able to develop a more detailed Wetland Management Strategy which would incorporate a set of management prescriptions that can ensure the proper management of wetlands and their ecological functions with cooperation from other State Government departments, private landholders and the general community.

The methodology requires that an entire wetland boundary line be traversed and although the method would appear to be time-consuming it is necessary to re-establish the full length of a boundary. Access is therefore required to all of the wetland and during this survey only one section of one wetland was encountered which could not be traversed. This occurred in a section of low closed forest of *Melaleuca nodosa* which had to be mapped. The antennas associated with the GPS equipment are 2 m high and the GPS is carried in a backpack — the dense vegetation made access with the equipment impossible.

Conclusions

The wetlands of the City of Gosford make an important contribution to the character of the estuarine systems of Brisbane Water. However, there is pressure on the wetlands from development and there is a need to integrate the development within an overall conservation plan for the wetlands. To achieve accuracy, ground location of wetland boundaries is required. GPS in conjunction with GIS has potential for updating the boundaries of wetlands for this purpose. The method can be slow depending upon the availability of satellites and topographical constraints. However, this project proved to be accurate and such accuracy will contribute to the conservation and management of wetlands.

One of the main conclusions derived from the survey was the presence of a zone of deterioration at the wetland boundary. This zone was found wherever fill was placed against a wetland for the purposes of development whether it be for a playing field or a housing estate. The zone of deterioration is caused by the encroaching fill material which gradually creeps onto the wetland and becomes colonised by exotic grasses and weeds. Only in certain circumstances was this zone absent, such as when a sandstone retaining wall was placed to support the fill material and prevent soil creep. Measures should be undertaken to ensure that developments do not infringe on wetland edges and that fill material is effectively retained on the development site.

Acknowledgments

We wish to thank all of the staff of Trehy, Ingold and Neate for data collection and preparation of the wetland boundaries. David Gee and Craig Palmer undertook the GPS survey and computer techniques. Mick Glossop gave advice on satellite technology. We would also like to thank Gosford City Council for allowing us to trial GPS. Doug Benson and the editorial committee are acknowledged for editing the manuscript and Margaret Payne for word processing.

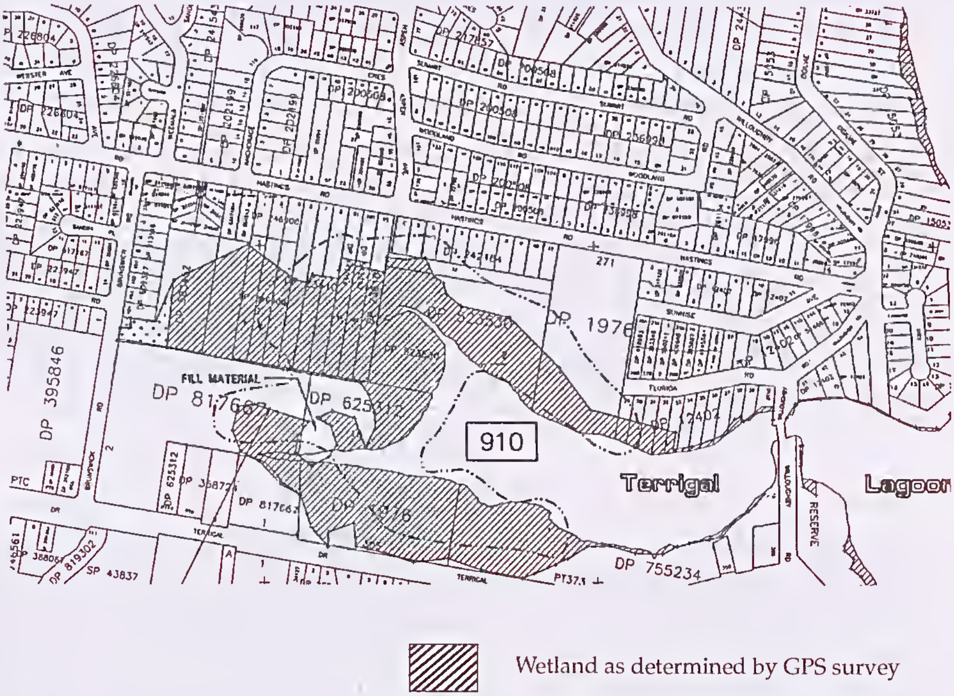

Fig. 4. Terrigal Lagoon showing the SEPP 14 boundary (— .. — .. —) and the same boundary determined by GPS survey. Note there ae large differences in position.

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Manuscript accepted 8 May 1998

Some New South Wales coastal plant distributions: a comparison of herbarium records with transect survey data.

Petrus C. Heyligers

Heyligers, P.C. (CSIRO Wildlife and Ecology, P.O. Box 84, Lyneham ACT 2602) 1998. Some New South Wales coastal plant distributions: a comparison of herbarium records with transect survey data. Cunninghamia *5(3): 645–664.* Some unexpectedly large gaps in the distribution data for herbarium specimens of several coastal dune species were investigated. Whether these gaps were due to 'undercollecting' or whether they reflected a true absence in the intervening areas was questioned. A floristic survey of NSW coastal dunes carried out by Clarke (1989a, b) made it possible to check relevant herbarium records against a set of systematically collected field data. Those for the following species held at Australian herbaria (BRI, CANB, GAUBA, MEL, NE, NSW, SYD and UNSW) were compared with the distributions as recorded by Clarke: *Spinifex sericeus, Calystegia soldanella, Stackhousia spathulata, Chamaesyce psammogeton, Canavalia rosea, Ipomoea pes-caprae, *Cakile edentula, *Cakile maritima, *Hydrocotyle bonariensis, *Arctotheca populifolia, *Gladiolus gueinzii* and **Oenothera drummondii* (* indicates introduced species). It was found that, by and large, the herbarium records were representative of the overall distribution patterns as established by the survey, but that less intensive collecting along the northern half of the coast had left gaps in the herbarium records which, more often than not, were not reflecting the true situation in the field.

Introduction

Herbarium records were used to analyse the dispersal ecology of introduced coastal dune plants with buoyant propagules along the southern Australian coastline (Heyligers 1983, 1989a, 1993, 1996). If older collection records were separated by large gaps, later collections often filled in such gaps to a greater or lesser degree. However, there also were cases where large gaps remained and I wondered whether this meant continued absence or 'undercollecting' along that particular stretch of coastline.

Everyone who is trying to work out species distributions from 'dot' maps based on collection records is faced by this 'gap' question, one which becomes especially pertinent where management decisions for rare species are involved. Often only additional fieldwork can solve the problem: search the right habitats at the right time and you may come up with the right answer.

By its very nature the coastal dune habitat is a restricted one and could relatively simply be investigated systematically. In 1987 P.J. Clarke carried out just such an investigation along the coast of New South Wales for the Soil Conservation Service: every dune system with a beach front longer than one kilometre was surveyed by means of one or more transects (Clarke 1989a, b; Clarke and Chapman 1989).

This meant a field database of 247 transects was available for comparison with records from herbarium collections.

Twelve species were chosen for making this comparison, six native and six introduced ones. These species combine a variety of characteristics: some are common, others less so; some are widespread, others of more localised occurrence; some are dispersed by water, others by wind; and last but not least, some have more conspicuous flowers than others, which may influence the chance of being collected.

The species

This section gives general information on the distribution in New South Wales and the means of dispersal of the species chosen for comparing herbarium records with survey results. For introduced species some information has also been provided about the time and probable location of introduction into Australia in general and into New South Wales in particular.

Native species

Spinifex sericeus R.Br. (Poaceae) is a common coloniser of primary dunes in eastern Australia (Heyligers 1988). The female plants produce large infructescences, which are dispersed by wind and secondarily by longshore currents.

Calystegia soldanella (L.) R.Br. (Convolvulaceae) grows in New South Wales in sandy and rocky coastal areas (Harden 1990–1993). It has buoyant seeds.

Chamaesyce psammogeton (P.S. Green) P.I. Forst. & R.J.F. Hend. (Euphorbiaceae) is endemic to south eastern Queensland, New South Wales and Lord Howe Island (Green 1993). It has long been known by the incorrect name of *Chamaesyce* (or *Euphorbia*) *sparrmanii*. It is uncommon on sand dunes near the sea (Harden 1990–1993). Its seeds are water-dispersed (Benson & McDougall 1995). If seed buoyancy characteristics of the distantly related *Euphorbia paralias* L. are anything to go by (Heyligers 1993), the seeds could remain afloat and viable for several years.

Stackhousia spathulata Sieber ex Sprengel (Stackhousiaceae) grows in heath and dry sclerophyll forest in sandy regions, often near beaches and lagoons, widespread in coastal districts (Harden 1990–1993). However, in my experience, it is a species of sporadic occurrence on coastal dunes in New South Wales and is more common along the southern coastline of the continent east of the Great Australian Bight. The fruits are probably only dispersed by wind.

Canavalia rosea (Sw.) DC. (Fabaceae) and *Ipomoea pes-caprae* (L.) R.Br. subsp. *brasiliensis* (L.) Oostr. (Convolvulaceae) are tropical to subtropical species which reach their southern distribution limits along the coast of New South Wales. *Canavalia rosea* occurs north from Shellharbour (Harden 1990–1993), *Ipomoea pes-caprae* chiefly north from Port Macquarie, but with some scattered occurrences in the Sydney area (Harden 1990–1993). Both are classic examples of plants with buoyant seeds.

Introduced species

Cakile edentula (Bigelow) Hook. and *Cakile maritima* Scop. (Brassicaceae) are both strandline pioneers. Their fruits consist of two one-seeded segments. On maturity, the distal segment breaks off and is dispersed by sea, while the lower one remains attached to the senescent plant. The species are difficult to tell apart, especially in the vegetative stage (Heyligers 1989b), and hence were treated as *Cakile* species in Clarke's survey.

It is likely that *Cakile edentula*, a species indigenous to the Atlantic coast of North America, entered Australia on sealers' or whalers' ships from New England, which operated in Bass Strait earlier last century. The first documented occurrences in this part of the world are specimens collected by von Mueller on Phillip Island in 1864. In 1870 Woolls made the first collection in New South Wales at Manly. *Cakile edentula* now occurs all along the New South Wales coast, although since the appearance of *Cakile maritima*, it has become rather rare along the southern half of the coast.

Cakile maritima, native to the shores of western Europe and the Mediterranean, was first collected in Australia in 1897 near Perth. In the 1930s it had become well established on beaches in the Adelaide area, from where it spread along the coast of south eastern Australia. The first collection in New South Wales was made in 1968 by Hope and McGillivray at Nadgee, south of Eden, and the second one by McBarron in 1969 near Woy Woy, north of Sydney. It is now common along the southern beaches of the state, while its northern distribution limit is presently near Forster.

Hydrocotyle bonariensis Lam. (Apiaceae), native to South America, is a widespread secondary coloniser of coastal dunes in New South Wales, especially common near river and lagoon outlets. It has water-dispersed fruits. The first Australian collection was made in 1893 at Botany Bay by Fletcher. In 1902 he, as well as Hamilton, collected specimens near Manly, while in 1917 the latter reported that 'its range as now known extends northerly to Newcastle, and as far south as Thirroul', about 50 km south of Sydney (Hamilton 1917).

Arctotheca populifolia (P. Bergius) Norlindh (Asteraceae) is a strandline and foredune pioneer with buoyant fruits, native to southern Africa (Heyligers 1983). In 1934 it was collected on a sand dune near the sea near Mungo in the Myall Lakes District by a Sydney University Expedition. Rarely locally common, it has spread mainly south and has now reached East Gippsland and Flinders Island. Its spread in a northerly direction has been much slower. In the early 1930s this species also appeared on beaches in southwestern Western Australia. However, the population which ensued from that introduction is distinctly different and now ranges from Geraldton to south eastern South Australia (Heyligers, unpubl. obs.).

Gladiolus gueinzii Kunze (Iridacae), native to South Africa, was collected for the first time in Australia by Munro in 1950 at Stockton, just north of Newcastle. Harden (1990–1993) states that it 'grows as a pioneer on fore dunes; between the Macleay River and Currarong', although Heyligers (1989b) had reported it further south, with locations near Narooma and Tathra at the southern extremity of its range. The winged seeds are wind-dispersed, while the buoyant corms are liable to exposure by stormtide erosion and subsequent washing away (Heyligers 1989b). Corms kept in seawater may remain viable for well over a year (Heyligers, unpubl. obs.).

Oenothera drummondii Hook. (Onagraceae) is native to North America. Its localised occurrence in Western Australia, where it is common in the dunes near Perth, is assumed to be due to its introduction as a garden plant (Smith 1985). In New South Wales it was first collected by P. Michael at Waratah near Newcastle in 1929, which could imply introduction with ballast. Growing on coastal sand, chiefly north from Sydney (Harden 1990–1993), this is a wind-dispersed species.

Methods

In 1996 information from specimen labels was obtained at the following herbaria which, in combination, were likely to hold a comprehensive set of collections made over time along the coast of New South Wales: the Australian National Herbarium (CANB, CBG), the State Herbarium of Queensland (BRI), the National Herbarium of New South Wales (NSW), the National Herbarium of Victoria (MEL), and the following university herbaria: Australian National University (GAUBA), University of New England (NE), University of Sydney (SYD) and University of New South Wales (UNSW). A breakdown of the number of New South Wales specimens consulted in each of these herbaria is provided in the Appendix.

For most of the native species there were at least some collections dating back to last century, so I thought it could be informative to incorporate a time dimension in the distribution maps. This might reveal whether at some stage collecting could be considered adequate for determining the general distribution of a particular species if not its relative density of occurrence. Three periods were used: before 1900 (h0), 1900 till 1946 (h1), and after 1946 (h2). The choice of the end of the last century as a cut-off date is arbitrary, but 1946 was chosen as the start of the post Second World War period, which heralded an increase of activity in many fields of human endeavour.

For the plotting of the transect survey data, I was generously provided with a reference dataset for the species under consideration. If doubt arose about the correctness of outlying records, the original field data sheets were checked for verification (although this does not preclude field error).

The category maps used for the compilation of the species distribution maps were produced at the Australian National Herbarium using a commercially available MAPINFO program. In the latter the 'before 1900' (h0) category has been plotted on the coastline, whereas the other ones (h1, h2) and the transect information (t) have been shown in rows parallel to the coast. In the case of the two *Cakile* species, the records for *Cakile maritima* have been plotted east of the transect data. The grid at the left gives the co-ordinates for the coastline and the pre-1900 records; that at the right refers to the transect data. In each of the four categories, multiple data from a collection location or a transect have been plotted as a single occurrence.

In the legend of each map the first date in the pre-1900 category refers to the year the first collection in New South Wales was made, while the last date in the post-1946 group indicates the most recent year of collection of an incorporated specimen at the time of my data-gathering in 1996. For introduced species the location of the first collection in New South Wales is indicated by the dot with the date of first collection adjacent to it.

The documentation of the herbarium and survey data used for the map compilations is given in Heyligers (1998).

Results and discussion

Native species

Spinifex sericeus was recorded from all transects except one. By 1900 there were enough records to indicate its occurrence all along the coast. While collections in the first half of this century were centred around the Sydney area, those from the second half give a fair indication of its local abundance from Port Macquarie to the Victorian border. However, based on transect data, *Spinifex sericeus* is still 'undercollected' along the northern beaches (Fig. 1).

Calystegia soldanella, as shown by the transect data, is common along the southern half of the coast, but only of scattered occurrence further north (Fig. 2). This pattern is also evident from the herbarium records, which show a trend over time similar to that of *Spinifex sericeus.*

Chamaesyce psammogeton occurs sporadically north from Ulladulla, a pattern well supported by the herbarium records (Fig. 3). As for the previous two species, collecting between 1900 and 1946 has been done mainly around Sydney. However, since 1946 it seems to have disappeared from this area. It has recently been listed as an endangered species under the NSW Threatened Species Conservation Act.

Stackhousia spathulata has a general distribution similar to that of *Chamaesyce psammogeton* but, as both herbarium and transect records show, is of even sparser occurrence and since 1946 has virtually disappeared from the coast between Coffs Harbour and Forster (Fig. 4). More recently, it has also become rare in the Sydney area. Due to this scattered occurrence Carolin & Clarke (1991) conclude: 'It is probably a species under threat because it occurs in small isolated populations.'

Although *Canavalia rosea* was already mentioned (and eaten) by John White, Surgeon-General to the First Fleet (Chisholm 1962), there are only a few collections of this species from last century (Fig. 5). (These include two made by Woolls, both without date. For these, 1870 was used as an approximation.) As Hamilton (1917), in his extensive review of the coastal flora of Sydney, makes no mention of *Canavalia rosea*, it is possible that the species had become locally rare due to its use as a vegetable. The collections made since 1946 show a decrease in number with increasing latitude. This correlates well with the results of the transect survey and is indicative of the sporadic and possibly temporary occurrences of this species towards the southern end of its distribution.

Ipomoea pes-caprae, as shown by the transect data, is common north from Seal Rocks but occasional south from there to Newcastle (Fig. 6). This pattern also emerged from the rather sparse herbarium record. The isolated southern collections were made at Jibbon Beach, Port Hacking, between 1947 and 1963.

Introduced species

As indicated by the results of the transect survey one or the other, or both, of *Cakile edentula* and *Cakile maritima* can now be found along almost every beach in New South Wales (Fig. 7). However, collecting has not kept up with the northward spread of these species. While *Cakile edentula* has already spread far into Queensland (Heyligers 1996), the herbarium record suggests it to be still absent from most of the northern coast of New South Wales. Similarly, although the record of *Cakile maritima* from Forster is a true indication of its northern limit in the early 1990s, my own field work has shown it to be present in the large gap south from there.

Hydrocotyle bonariensis is now present along the entire New South Wales coast. Its greater frequency of occurrence in the central part of this range could be due to a continuing spread from the initial locus of introduction, a presumption fairly well supported by the general pattern emerging from the herbarium records (Fig. 8). But, as for *Cakile edentula*, the large gaps between the more recent herbarium records from the northern coastline do not adequately represent the present distribution.

Arctotheca populifolia presently occurs south from Smoky Cape with varying abundance but is rare south from Narooma (Fig. 9). This pattern is rather well represented by herbarium records although the paucity of collections north from Forster does not correlate with the high frequency of occurrence in the field.

Gladiolus gueinzii has a similar distribution to *Arctotheca populifolia*, but its occurrences are more frequent (Fig. 10). Except for a gap in the Ulladulla area, it is reasonably well represented by herbarium collections.

The scattered herbarium records of *Oenothera drummondii* are remarkably well confirmed by the results of the transect survey (Fig. 11).

Conclusions

From an overall perspective and depending on the species under consideration, the herbarium records were generally representative of the overall distribution patterns as established by the transect survey. It is also clear that collecting along the northern half of the coast has been less intensive than along the southern. This has left gaps in the records which, especially in the case of more common species, do not reflect the real situation.

The following more general conclusions about the applicability of the results should be viewed with some caution because of the small sample size:

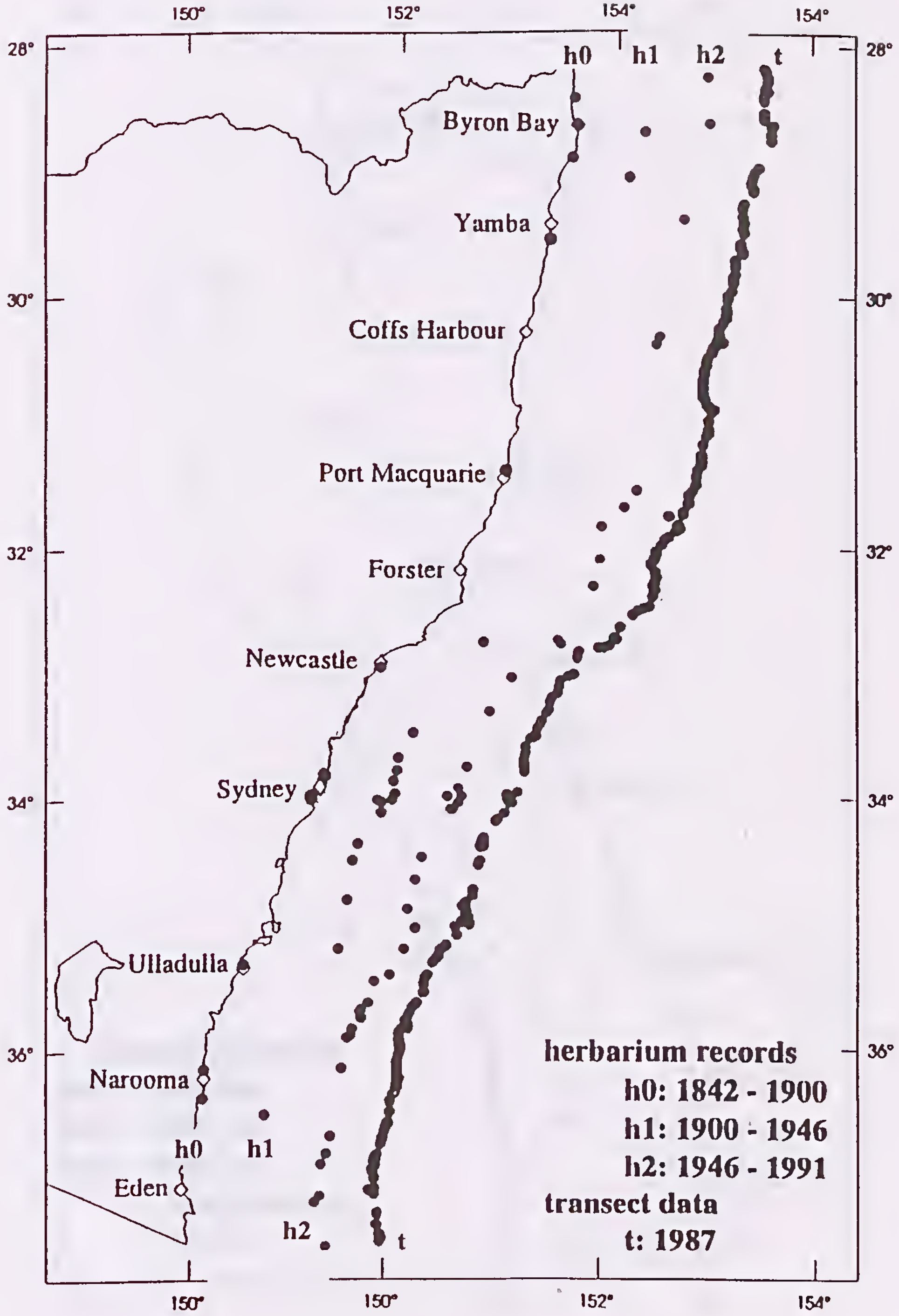

Fig. 1. Distribution of *Spinifex sericeus.*

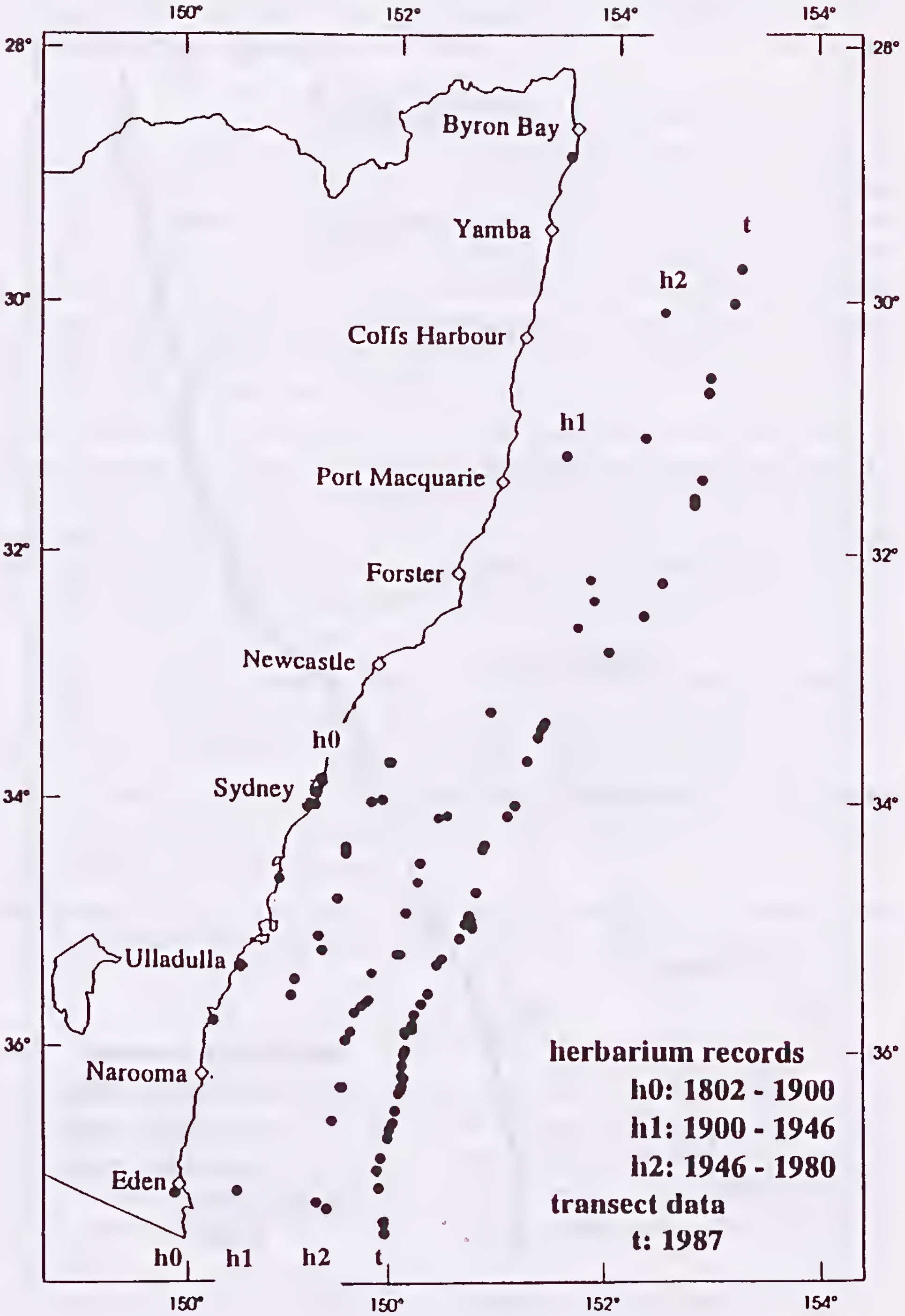

Fig. 2. Distribution of *Calystegia soldanella*.

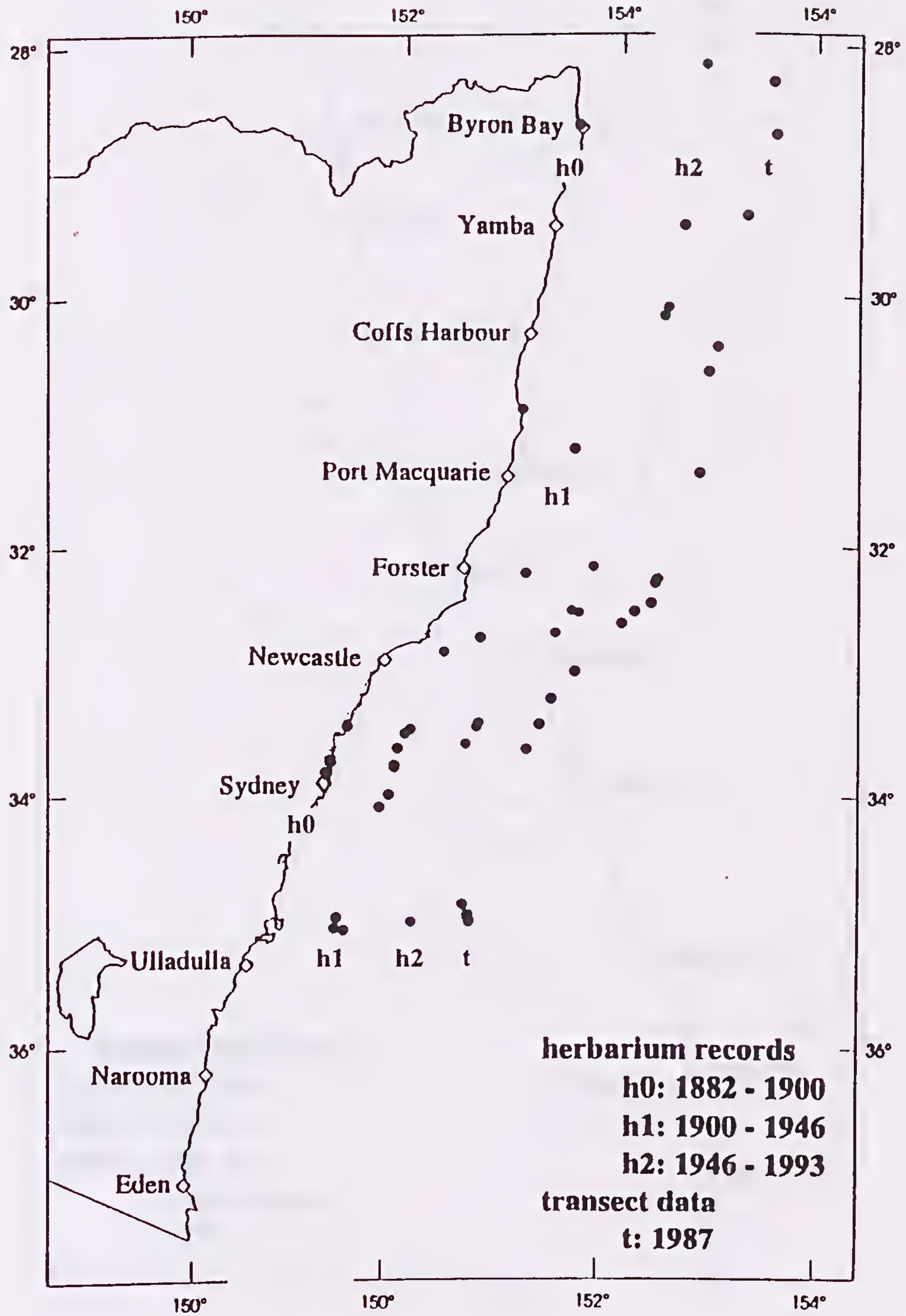

Fig. 3. Distribution of *Chamaesyce psammogeton*.

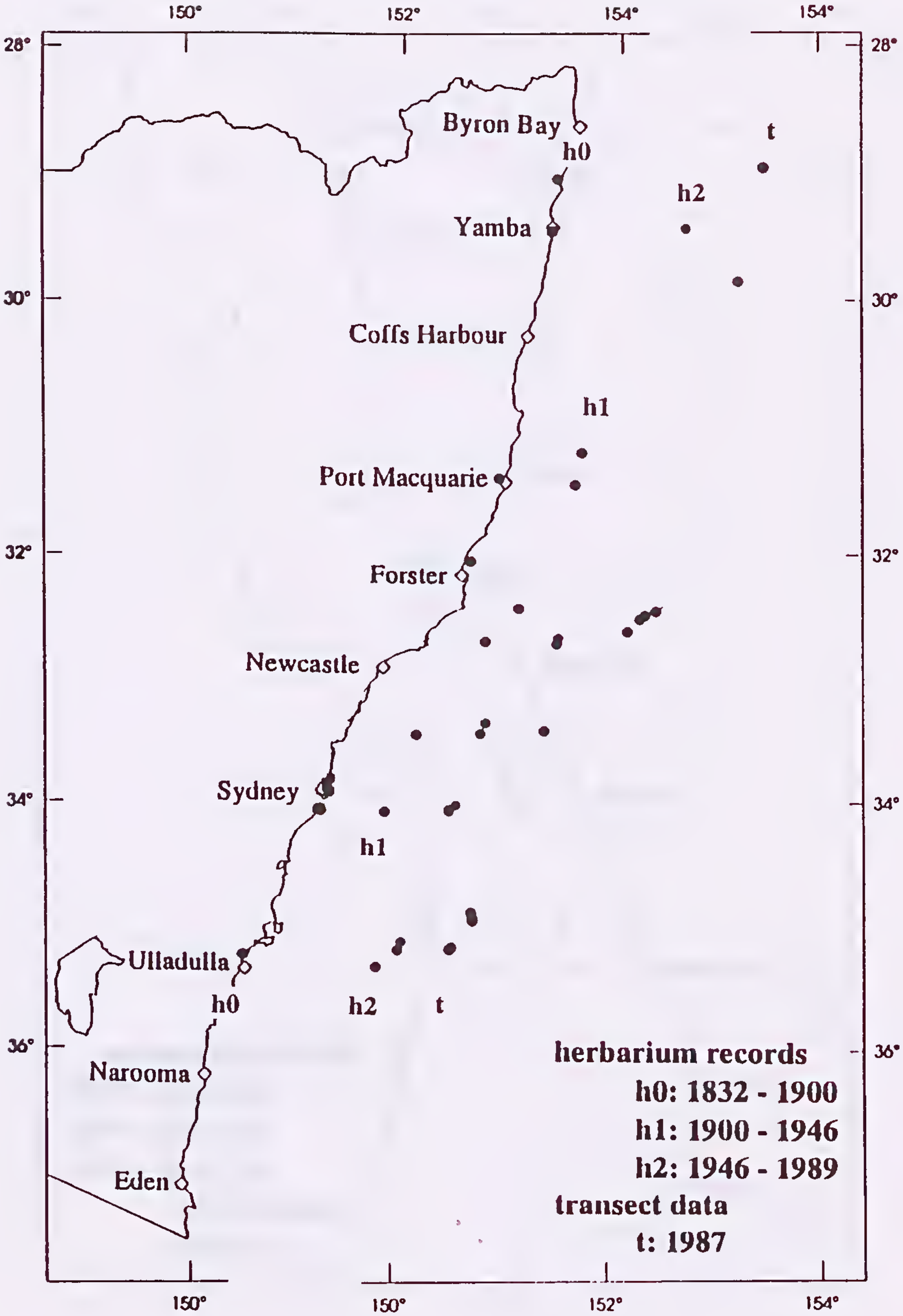

Fig. 4. Distribution of *Stackhousia spathulata*.

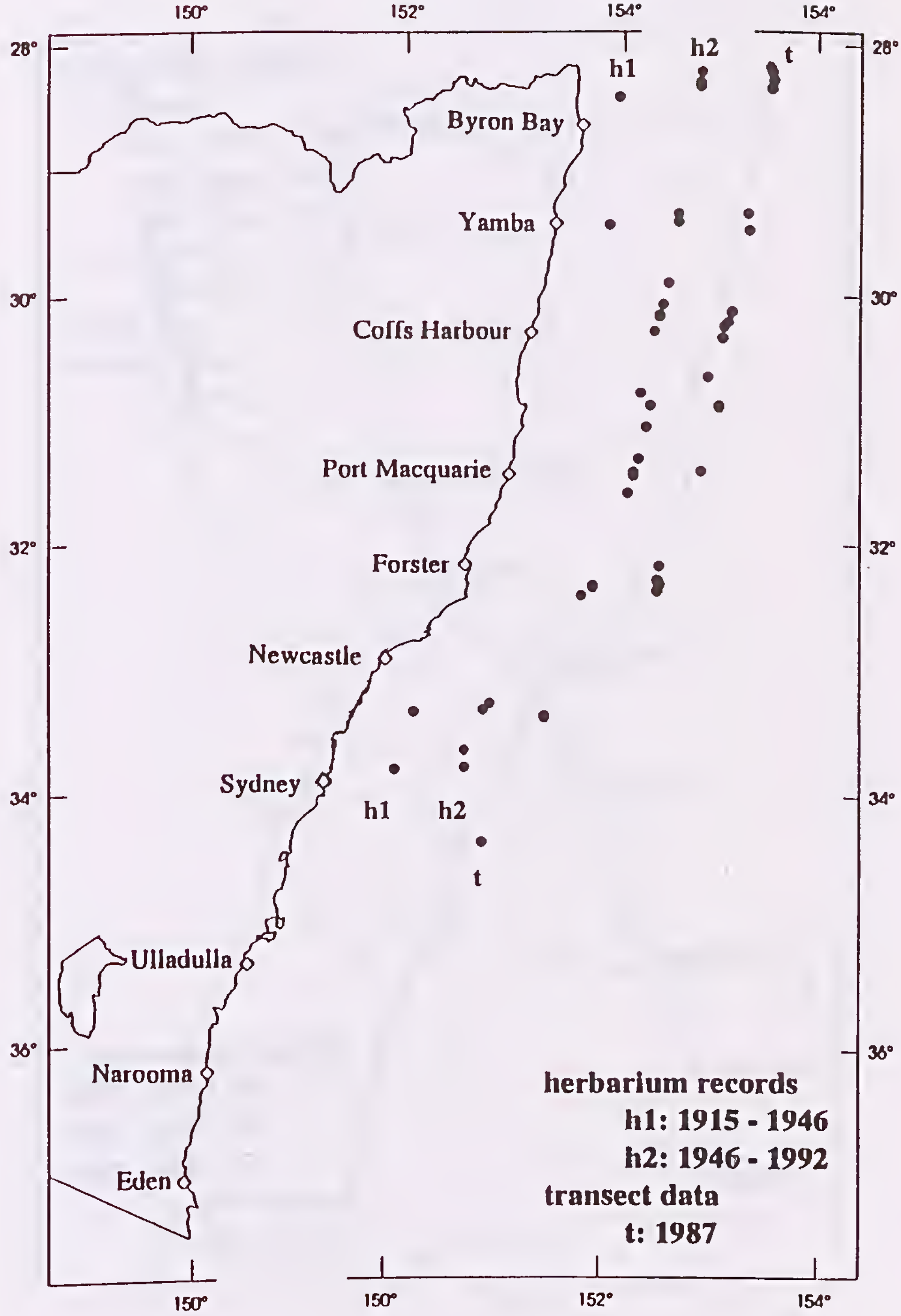

Fig. 5. Distribution of *Canavalia rosea*.

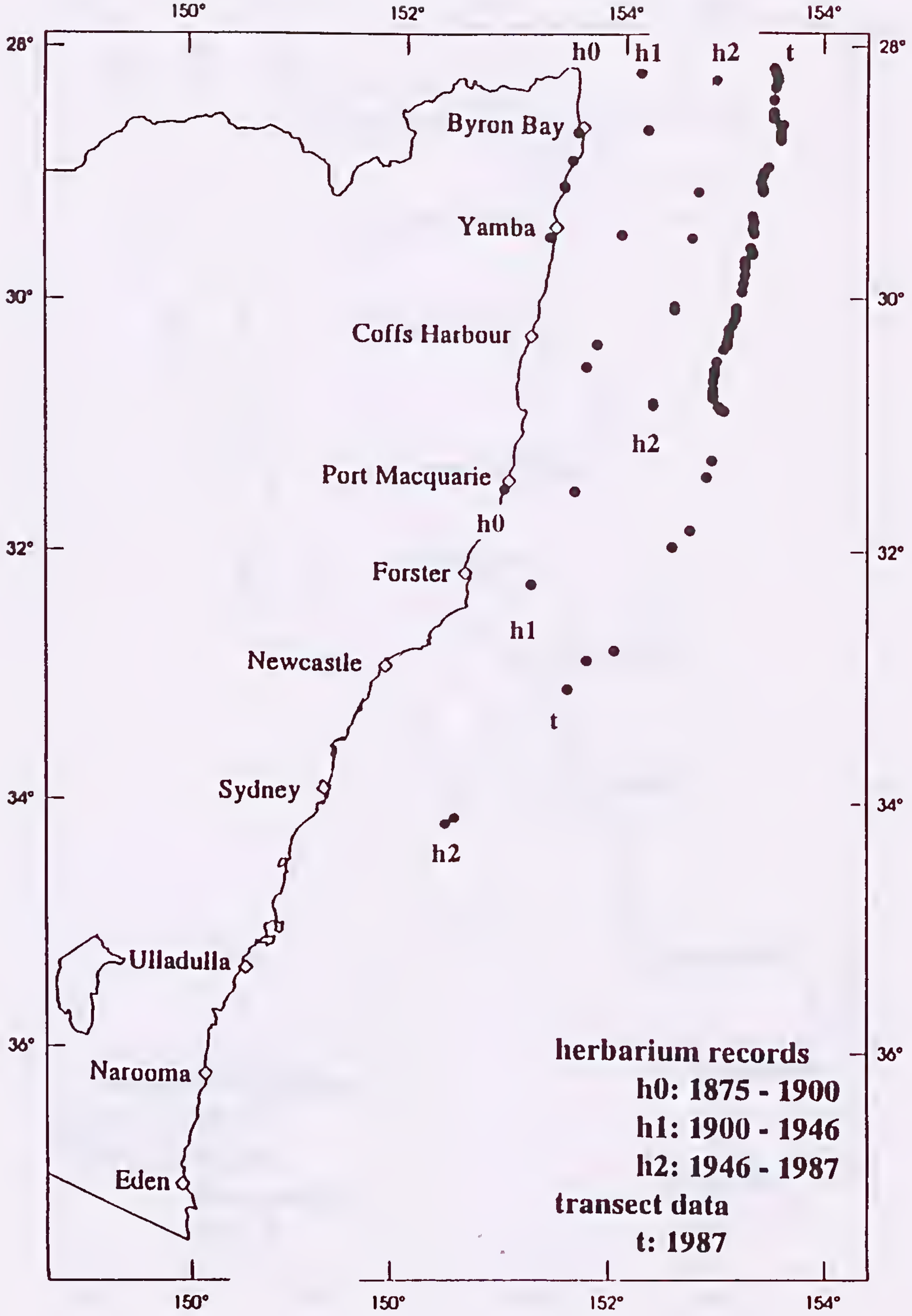

Fig. 6. Distribution of *Ipomoea pes-caprae*.

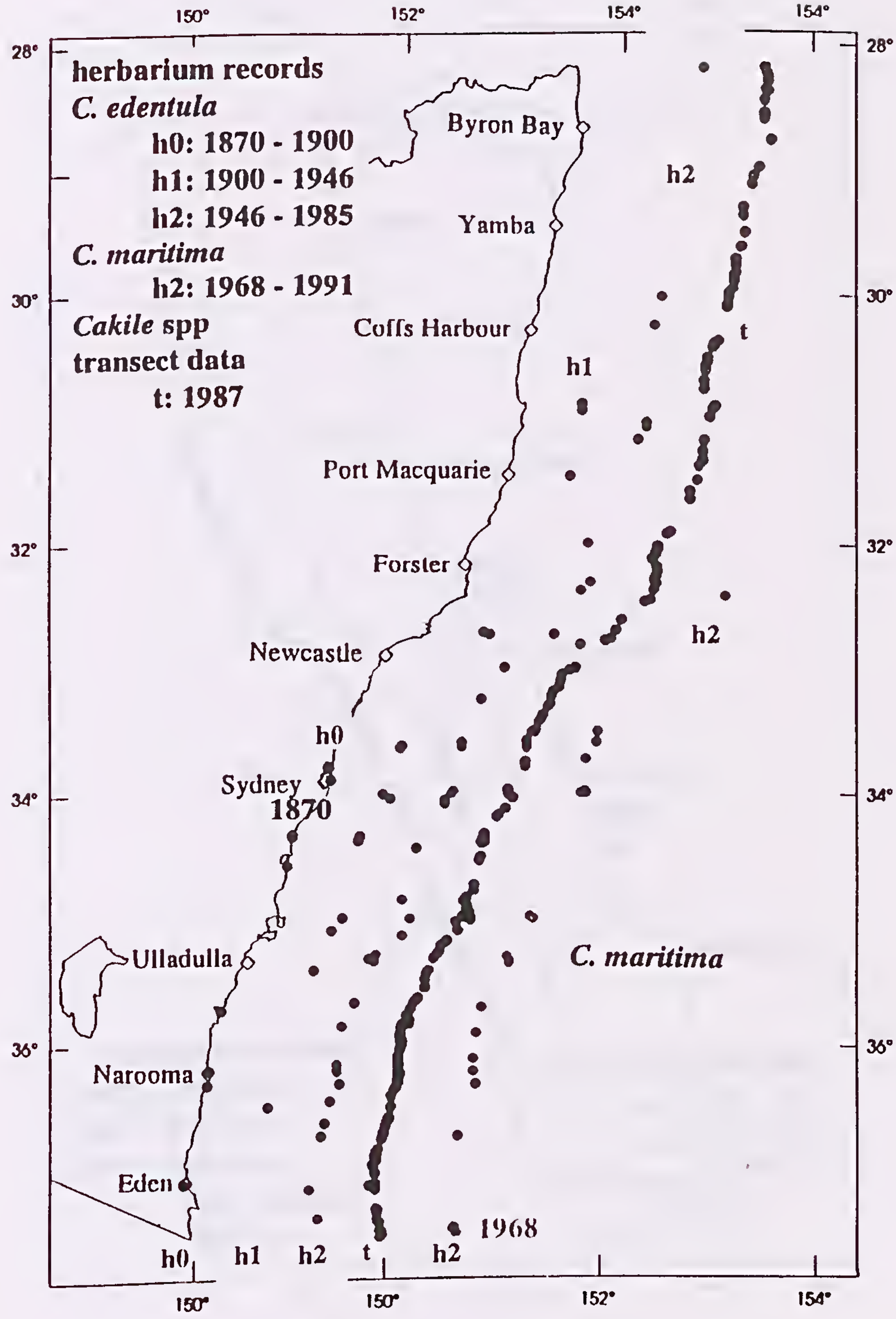

Fig. 7. Distribution of *Cakile edentula*, *Cakile maritima*.

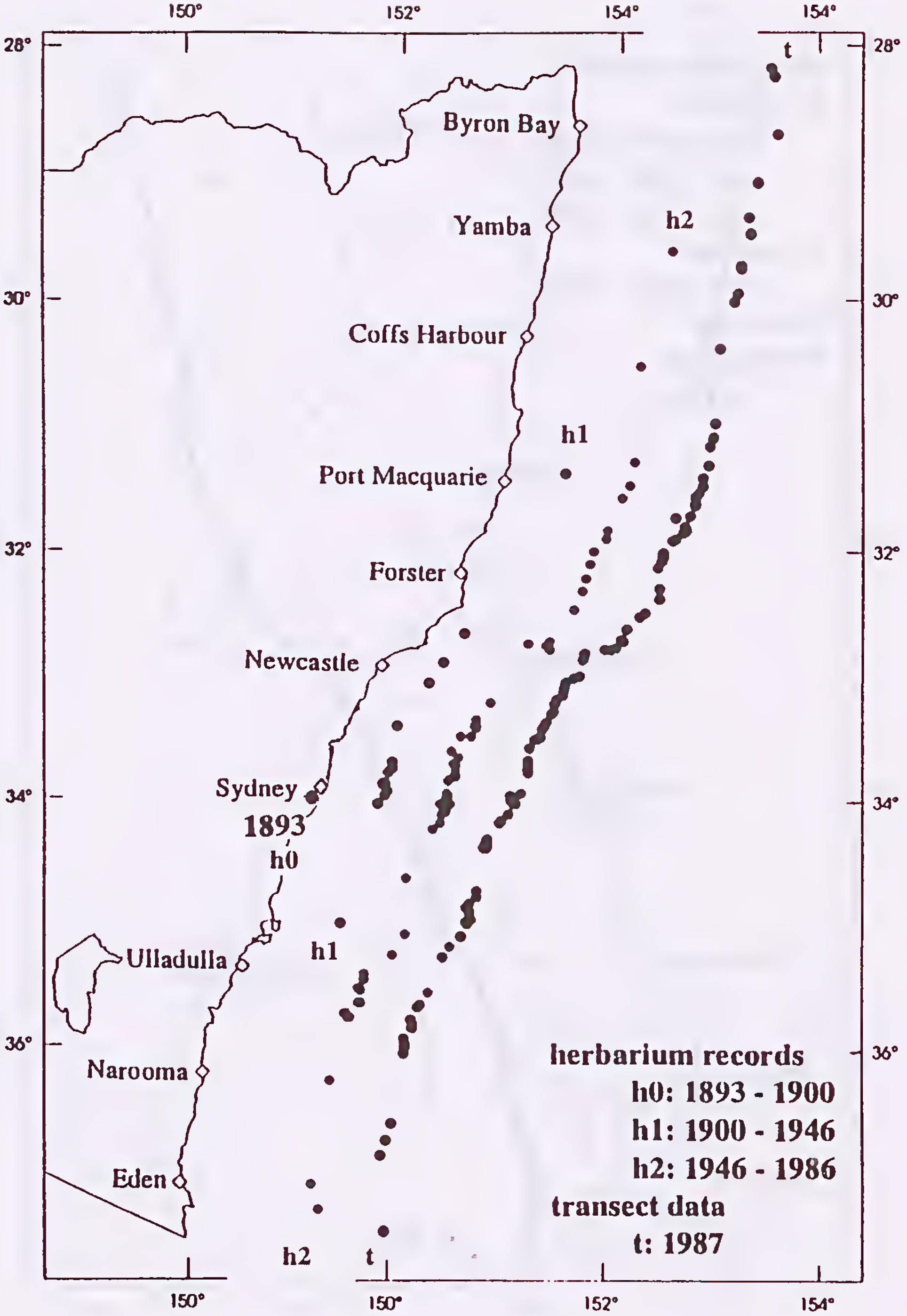

Fig. 8. Distribution of *Hydrocotyle bonariensis.*

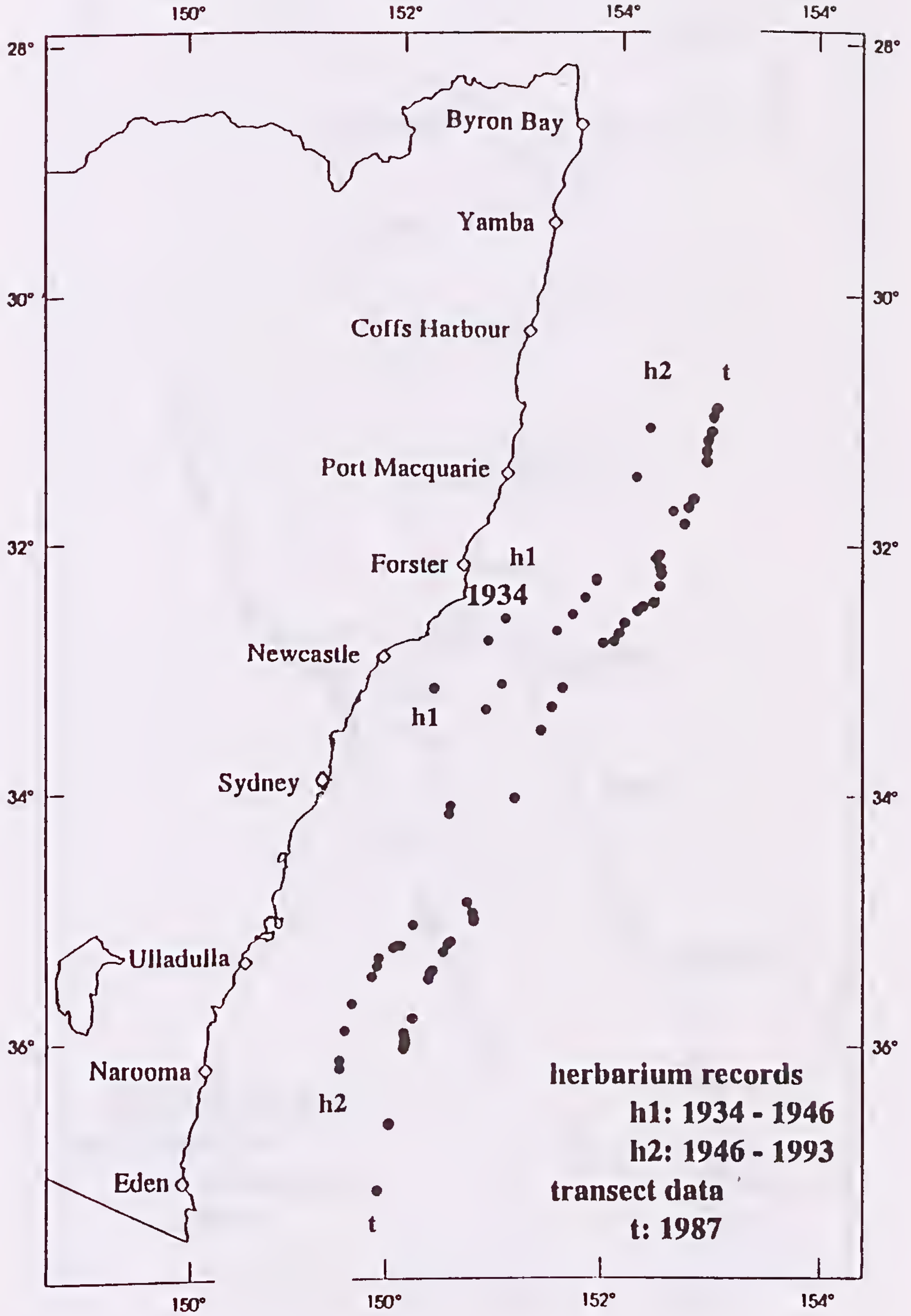

Fig. 9. Distribution of *Arctotheca populifolia*.

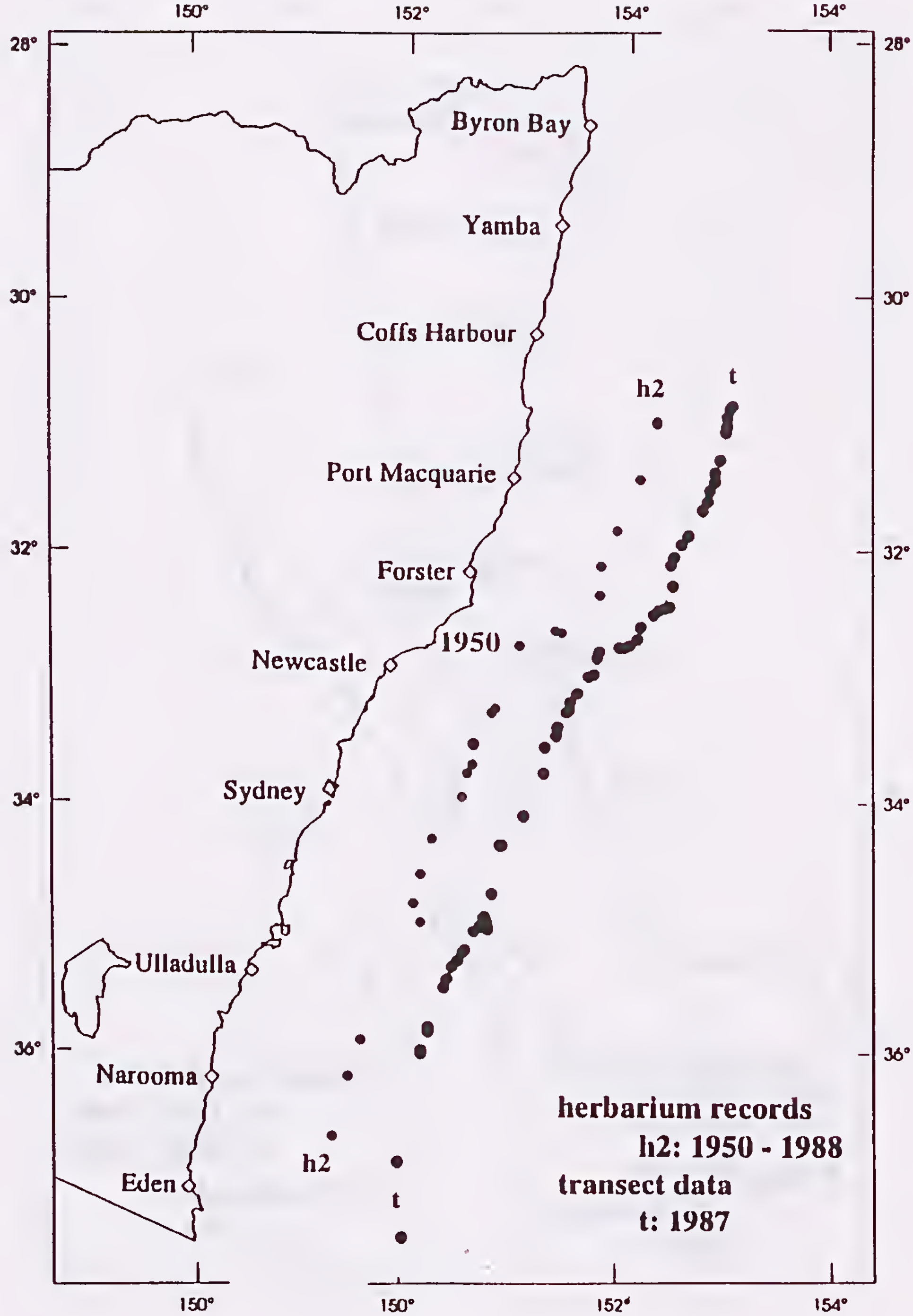

Fig. 10. Distribution of *Gladiolus gueinzii.*

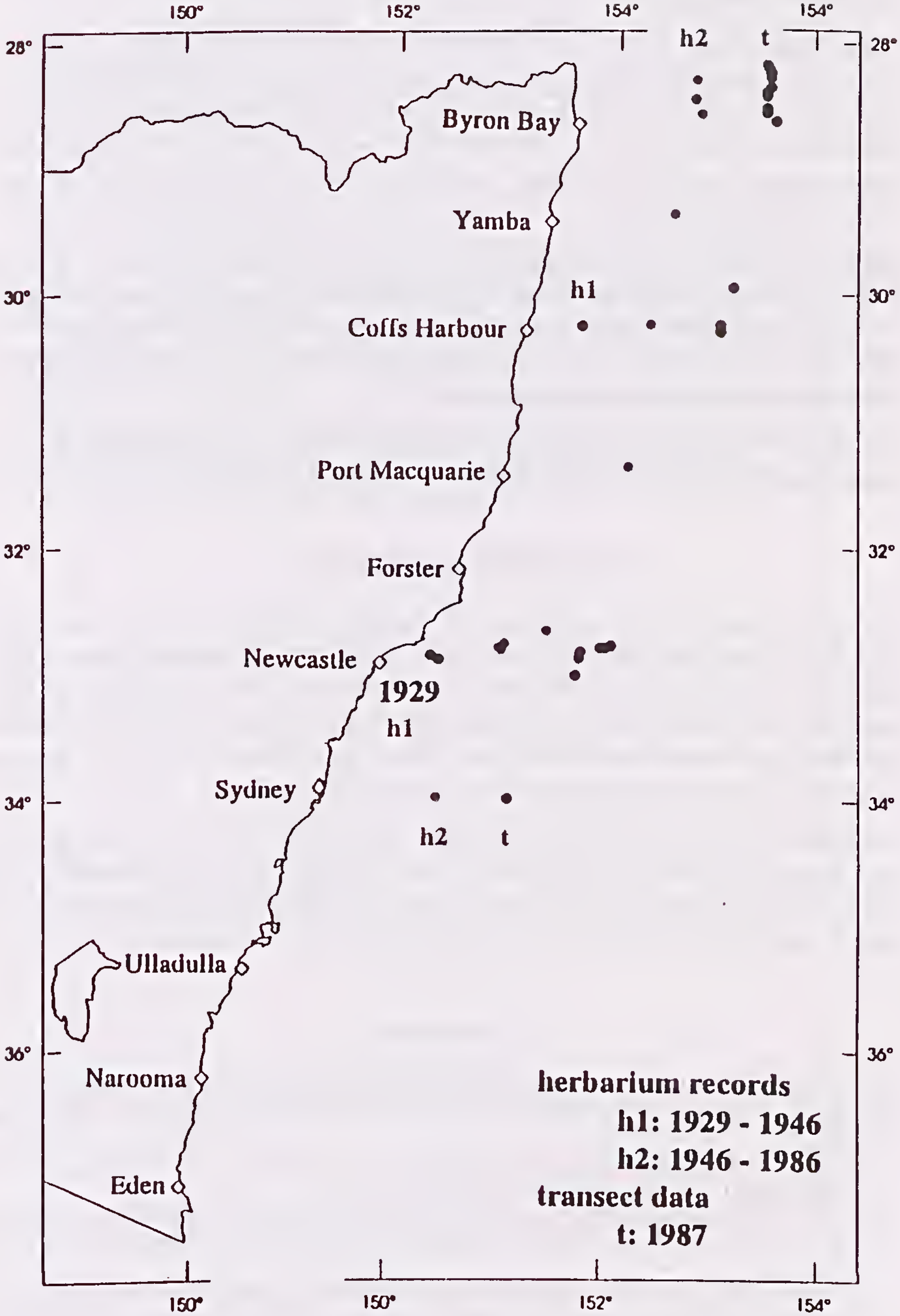

Fig. 11. Distribution of *Oenthera drummondii.*

Contrary to what one would like to assume, even for widespread and common species (like *Spinifex sericeus*) the herbarium records may give incomplete coverage of distribution in the field.

If one looks at less common but nevertheless widespread species (like *Chamaesyce psammogeton* and *Stackhousia spathulata*) one has no a priori means to judge the adequacy of the herbarium record, nor is one to know whether absence of recent collections from an area where the species had been collected before means disappearance from that particular location or whether there just have not been further collecting activities.

Obviously, systematic surveys provide invaluable information; however, if at all feasible, voucher specimens should be collected (and deposited in an herbarium) where any doubt arises about identity (as in the case of *Cakile*) or where occurrences appear to be out of normal range. A well-annotated herbarium specimen is a priceless record that appreciates in value as time goes by!

To end with the major conclusion from my comparisons: If one wants to be sure that a gap exists, than there is no escape from actual checking in the field.

Acknowledgments

Herbaria are treasure chests of information. I thank Heads, Curators and staff of BRI, CANB, GAUBA, MEL, NE, NSW, SYD and UNSW for again allowing me to have a glimpse at the treasures under their care. To Dr P.J. Clarke (University of New England) I am much obliged for permitting the use of his data, to Dr D.M. Chapman (University of Sydney) for prying these out of the database, and to P.A. Hohnen (CANB) for transforming my compilations into visual reality.

I am grateful to Dr B. Walker, Chief of CSIRO Wildlife and Ecology, for having me as an honorary member in his Division, to my colleagues for their friendship and support, and to D. Benson (NSW), Dr P.J. Clarke, Dr R. F. Parsons (La Trobe University) and an anonymous referee for commenting on the draft of the paper.

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Manuscript accepted 8 May 1998

Appendix 1. Number of collections from New South Wales consulted in each of the herbaria for the compilation of the maps.

In the following table the raw number of collections inspected in each herbarium is given; that is to say, duplicates have usually been included as well. Thus the totals given at the bottom of the table are somewhat larger than the number of records actually used. The last row gives the number of transects on which a particular species was recorded.

The species names have been abbreviated as follows:

Spin	*Spinifex sericeus*	C. ed	*Cakile edentula*
Caly	*Calystegia soldanella*	C. ma	*Cakile maritima*
Cham	*Chamaesyce psammogeton*	Hydr	*Hydrocotyle bonariensis*
Stac	*Stackhousia spathulata*	Arct	*Arctotheca populifolia*
Cana	*Canavalia rosea*	Oeno	*Oenothera drummondii*
Ipom	*Ipomoea pes-caprae*	Glad	*Gladiolus gueinzii*

	Spin	**Caly**	**Cham**	**Stac**	**Cana**	**Ipom**	**C. ed**	**C. ma**	**Hydr**	**Arct**	**Oeno**	**Glad**
BRI	*	3	0	0	2	*	1	0	1	0	1	0
NE	13	2	0	5	7	3	3	1	7	0	3	0
NSW	45	35	27	16	27	14	36	11	51	17	18	24
SYD	11	6	5	5	2	7	5	2	5	2	0	2
UNSW	9	0	3	2	5	1	1	3	2	3	0	4
CANB	11	7	2	4	6	0	21	14	23	12	14	6
GAUBA	5	3	0	4	1	2	3	0	3	1	1	0
MEL	9	8	3	8	5	8	8	1	10	1	0	0
Total	103	64	40	44	58	35	78	32	102	36	26	36
Transect	246	58	19	12	19	65	194**		128	43	20	66

* Collections not checked.

** *Cakile* spp.: *Cakile edentula* and *Cakile maritima* not differentiated.

The vegetation of the Scotia 1: 100 000 map sheet, western New South Wales

M.E. Westbrooke, J.D. Miller and M.K.C. Kerr

Westbrooke, M.E., Miller, J.D. and Kerr, M.K.C. (Centre for Environmental Management, University of Ballarat, PO Box 663 Ballarat, Victoria, Australia 3353) 1998. The vegetation of the Scotia 1: 100 000 map sheet, western New South Wales. Cunninghamia *5(3): 665–684.* The vegetation of the Scotia 1: 100 000 map sheet 7131 (latitude 33°43'S, longitude 143°02'E) in south western New South Wales was assessed through analysis of 498 quadrats and mapped using ground truthing, aerial photograph interpretation and Landsat Thematic Mapper satellite image analysis. Three hundred and eighty species of vascular plants including 62 (16%) exotic species were recorded from 66 families. Four species were new records for New South Wales and a further five species are of conservation significance. Seventeen vegetation communities were identified, of which the most widespread were *Eucalyptus* spp. open shrubland and *Casuarina pauper* woodland/open woodland. The area contains significant communities that are not included in conservation reserves and examples of communities which are amongst the most intact in NSW.

Introduction

The Scotia 1: 100 000 map sheet covers an area of 258 800 ha in far south western New South Wales, 150 km north-west of Wentworth and adjacent to the South Australian border, latitude 33°43'S, longitude 143°02'E (Fig. 1). The southern section is located within the Wentworth Shire and the remainder is unincorporated. The Scotia comprises all of four and part of seven other western division pastoral leases. It is bounded by pastoral leases to the north, south and east and Danggali Conservation Park in South Australia to the west. It is within the Murray Darling Depression bioregion (Thackway & Cresswell 1995).

History of the area

The Scotia has one of the shortest stock grazing histories of western NSW, the majority of the constituent properties having been created as pastoral leases in the 1920s. Previously the area was part of the large Lake Victoria lease and stock grazing occurred only in wet years (Withers 1989). During the 1980s a number of the leases were purchased as extensions of other district properties but in the 1990s this trend was reversed (P. Clark, NSW Dept. Land & Water Conservation, pers. comm.). In 1994 the Tarawi lease was purchased by the NSW National Parks & Wildlife Service as a nature reserve and the Ennisvale and Tarrara leases were purchased to be managed jointly as a private nature reserve. Stocking rates in the Scotia have always been low due to the difficulty in providing water and the unpalatable nature of the dominant mallee vegetation (Stanley & Lawrie 1980). This situation is now changing through more efficient reticulation of water through PVC pipe leading to higher and more widespread stocking rates.

Climate

The climate is classified as cool semi-arid (Dick 1975), the area being within climatic zone 1B for New South Wales (Edwards 1979): temperatures are high in summer and mild in winter with average daily maxima of 32°C in February and 15°C in July respectively and average daily minima of 16°C in February and 5°C in July. The mean annual rainfall is approximately 250 mm; the seasonal distribution of rainfall is fairly even but annual variation is high.

Geology and geomorphology

The study area lies within the Murray Basin geological province and consists of Quaternary material, with little rock outcropping (Lawrie & Stanley 1980).

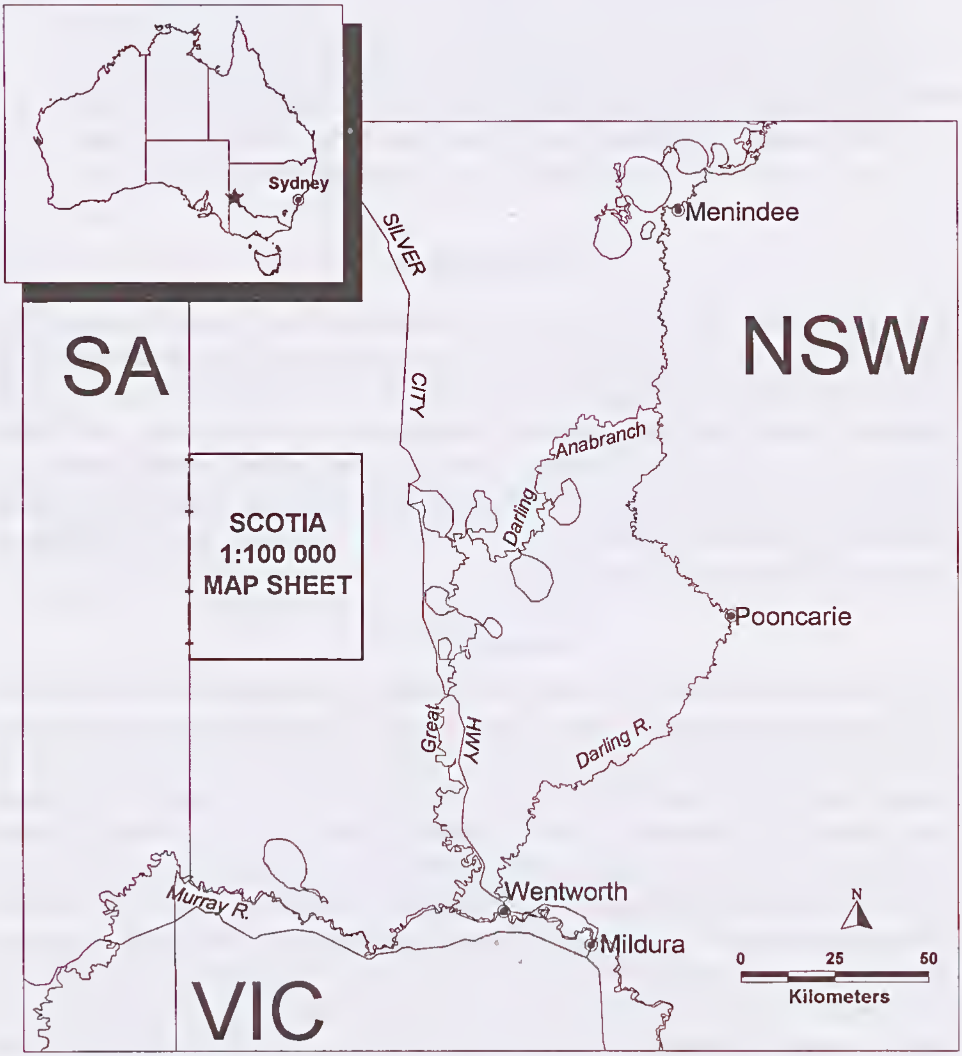

Fig. 1. Location of Scotia 1: 100 000 map sheet, western New South Wales.

Two broad land systems dominate the landscape: dunefields consisting of low parallel ridges running east–west composed of red earthy sands and sandy solonised brown soils overlying sandy clays; and calcareous sandplains of loam or sandy loam solonised brown soils often with limestone nodules at the surface (Walker 1991). A number of salt lakes occur within the area. The largest complex of salt lakes, referred to as the Scotia Discharge Complex, has been the subject of a detailed hydrological study by Ferguson et al. (1995).

Previous studies

The most complete study of the vegetation of far western New South Wales is that by Beadle (1945, 1948) who included the study area as *Eucalyptus dumosa–Eucalyptus oleosa* association. Noy-Meir (1971) carried out a quantitative analysis of the large area of *Eucalyptus* shrubland in south western New South Wales and north-west Victoria. More recently the National Herbarium of NSW, Sydney, has mapped the vegetation of the Ana Branch–Mildura (Fox 1991), Balranald–Swan Hill (Scott 1992) and Pooncarie (Porteners et al. 1997) 1: 250 000 map sheets. Detailed survey and mapping of vegetation in Mallee Cliffs National Park (Morcom & Westbrooke 1990) and Mungo National Park (Westbrooke & Miller 1996), to the south-east of the area, has also been undertaken. Mapping the area at 1: 100 000 scale revealed communities not previously recognised, particularly around the salt lakes, and enabled greater definition of the mosaics presented at 1: 250 000 scale.

Methods

Following preliminary survey, 498 × 0.09 ha (30 m × 30 m) quadrats were sampled and all vascular plant species occurring were recorded. Also recorded was a cover abundance value, modified from Braun–Blanquet (1928) for each species. Quadrats were subjectively located following the method of Gullan (1978). This method ensured that all communities were sampled and provided data on floristic variability within the communities. Communities were in general sampled in proportion to the area they covered however, since many quadrats were located along transects wherever community type was observed to change, those with a discontinuous distribution may have been over-sampled. Sampling was undertaken between February 1993 and October 1995. Data from the quadrats were analysed via a computer-based numerical classification procedure coupled with a hand sorting procedure of the type outlined in Gullan (1978). A species list was compiled incorporating all vascular plant species recorded from sampled quadrats and following opportunistic collection. Further restricted communities recorded during the field work but not evident from the numeric classification were added to the final classification to provide 16 vegetation communities. For each community mean species richness, total species richness and number of exotic species as a proportion of the total number of species were calculated (Table 1).

During surveys, ground truthing was undertaken by driven and walked transects. Information from these transects was used in conjunction with study of colour aerial photographs and Landsat Thematic Mapper satellite image data (Scene 96–83) to produce a vegetation map at 1: 100 000 scale. The mapped vegetation communities were defined by floristic and structural characteristics (Specht 1970). All processing and manipulation of the digital satellite data was conducted using ER Mapper 5.2 (Earth Resource Mapping Pty. Ltd.). A supervised classification of the image, based on training sets derived from the vegetation classification, was undertaken. Eight communities from the vegetation classification were able to be mapped at this scale. Additional vegetation types of restricted occurrence, e.g. those dominated by *Acacia aneura*, *Acacia loderi*, and *Callitris glaucophylla*, were located as points on the map. The classified image was transferred to the MapInfo Geographic Information System (Mapinfo Corporation, Troy, New York) database for final production of the vegetation map.

Table 1. Relative area, sampling intensity, species richness and weediness of plant communities of the Scotia map sheet

Community	**Area %**	**No. Quadrats**	**Mean Species Richness/ quadrat**	**Mean % Weediness**	**Total Species Richness**
1a *Casuarina pauper* woodland/ open-woodland	15	133	18	6	206
1b *Eucalyptus largiflorens* open-woodland	< 1	1	18	42	18
1c *Callitris glaucophylla* open-woodland	< 1	4	22	11	57
1d *Hakea leucoptera* low open-woodland	< 1	15	23	5	104
1e *Hakea tephrosperma* low open-woodland	< 1	6	34	13	88
2a *Eucalyptus* spp. open-shrubland with shrub understorey	25	59	21	3	151
2b *Eucalyptus gracilis/Melaleuca lanceolata*, open-shrubland	< 1	25	14	1	75
2c *Eucalyptus* spp. open-shrubland with *Triodia* understorey	50	216	19	1	207
2d *Eucalyptus porosa* low open-woodland	< 1	1	24	25	25
3a *Acacia aneura* open-shrubland	< 1	5	23	9	103
3b *Acacia loderi* tall open-shrubland	< 1	1	24	13	24
4a *Dodonaea/Eremophila* shrubland	5	46	22	14	215
4b *Atriplex vesicaria* low open-shrubland	2	10	11	5	53
4c *Halosarcia/Frankenia/Osteocarpum* low open-shrubland	2	32	8	2	96
4d *Halosarcia lylei* low open-shrubland	< 1	3	3	0	2
5a *Eragrostis australasica* tussock grassland	< 1	1	12	25	12
5b Herbland	< 1	2	2	41	37

Results

Vegetation

The vegetation of the study area consists predominantly of *Eucalyptus gracilis/Eucalyptus dumosa/Eucalyptus socialis* open shrubland and *Casuarina pauper* open woodland but 16 distinct communities were recognised (Table 1). While several of the communities are of limited distribution they add significantly to the conservation values of the area. The approximate percentage area occupied by each community, the sampling intensity, mean species richness, total species richness and mean percentage weediness of these communities are given in Table 1.

All vegetation communities are described below, grouped according to structural and floristic attributes.

1. Woodlands

1a *Casuarina pauper* woodland/open-woodland

Casuarina pauper, growing to 10–12 m, occurs as a dominant species on the brown loamy sands of interdune areas. It is frequently associated with *Alectryon oleifolius* subsp. *canescens* and/or *Myoporum platycarpum* and *Geijera parviflora*. Commonly associated understorey shrubs are *Enchylaena tomentosa, Chenopodium curvispicatum, Maireana pentatropis, Maireana georgei, Sclerolaena obliquicuspis, Eremophila sturtii, Olearia muelleri, Senna artemisioides* nothosp. *filiformis*, *Senna artemisioides* nothosp. *petiolaris* and *Senna artemisioides* nothosp. *coriacea*. Frequently-occurring grasses and herbs include *Stipa* spp., *Vittadinia cuneata* and *Dissocarpus paradoxus*.

Five sub-communities can be recognised although these may relate to past land use rather than edaphic factors.

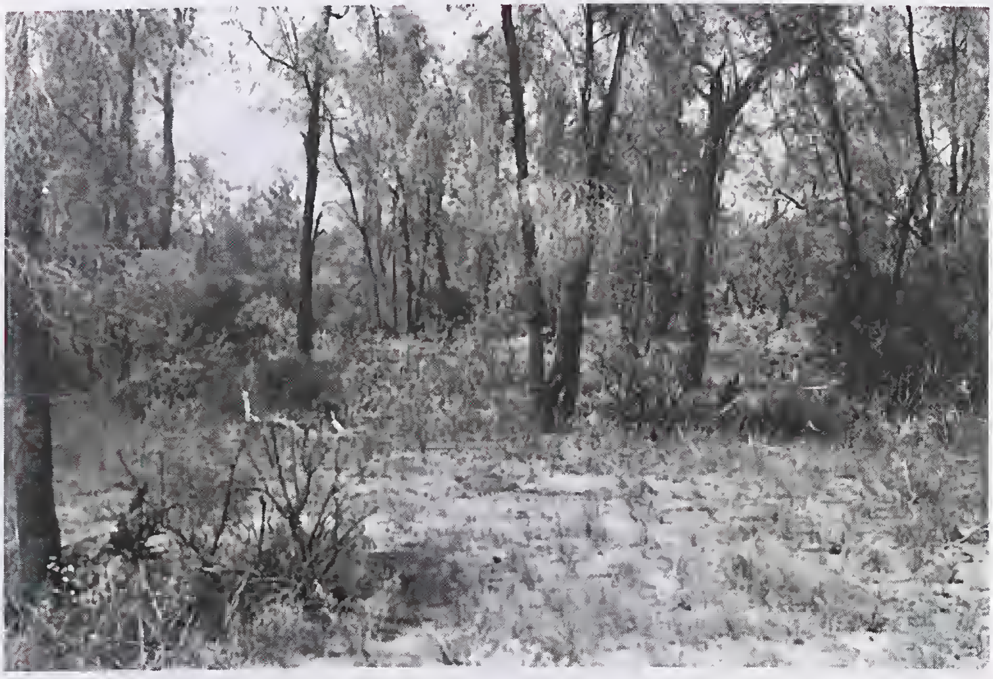

Fig. 2. A feature of much of the *Casuarina pauper* woodlands is the rich shrubby understorey.

- *Casuarina pauper/Alectryon oleifolius* subsp. *canescens* open-woodland with a diverse shrubby understorey (Fig.2).
- *Casuarina pauper* occurring as dense monospecific woodland.
- *Alectryon oleifolius* subsp. *canescens* occurring as dense groves.
- *Myoporum platycarpum* open-woodland.
- *Geijera parviflora* open-woodland.

1b *Eucalyptus largiflorens* open-woodland

A single stand of *Eucalyptus largiflorens* open-woodland to 10 m occurs near the old Moskeg woolshed in the south of the area. The understorey is dominated by exotic herbs and grasses.

1c *Callitris glaucophylla* open-woodland

Callitris glaucophylla (10 m tall) occurs as the dominant tree on a few sandy ridges. The community carries an open understorey of herbs and grasses including the native species *Actinobole uliginosum, Calandrinia eremaea, Calotis hispidula, Crassula colorata, Rhodanthe moschata, Tetragonia tetragonioides* and *Zygophyllum ammophilum* with a very high occurrence of exotic weeds including *Brassica tournefortii, Bromus rubens, Erodium cicutarium, Hypochoeris glabra, Medicago polymorpha* and *Sisymbrium irio*.

1d/1e *Hakea leucoptera/Hakea tephrosperma* low open woodland

In a number of locations a low open-woodland with a near monospecific overstorey of *Hakea leucoptera* or *Hakea tephrosperma* to 7 m occurs with an understorey of grasses and herbs.

2. Eucalypt shrublands (mallee)

2a *Eucalyptus oleosa/Eucalyptus gracilis/Eucalyptus dumosa* open-shrubland

Eucalyptus open-shrubland dominated by *Eucalyptus oleosa*, *Eucalyptus gracilis,* and *Eucalyptus dumosa* to 8 m occurs on interdune plains of sandy-loam solonised soils. Associated understorey shrubs include *Enchylaena tomentosa, Chenopodium curvispicatum, Chenopdium desertorum, Atriplex stipitata, Maireana pentatropis, Maireana georgei, Sclerolaena obliquicuspis, Eremophila sturtii, Olearia muelleri, Senna artemisioides* subspecies, *Myoporum platycarpum, Dodonaea viscosa* subsp. *angustissima* and *Acacia colletioides*. Frequently-occurring grasses

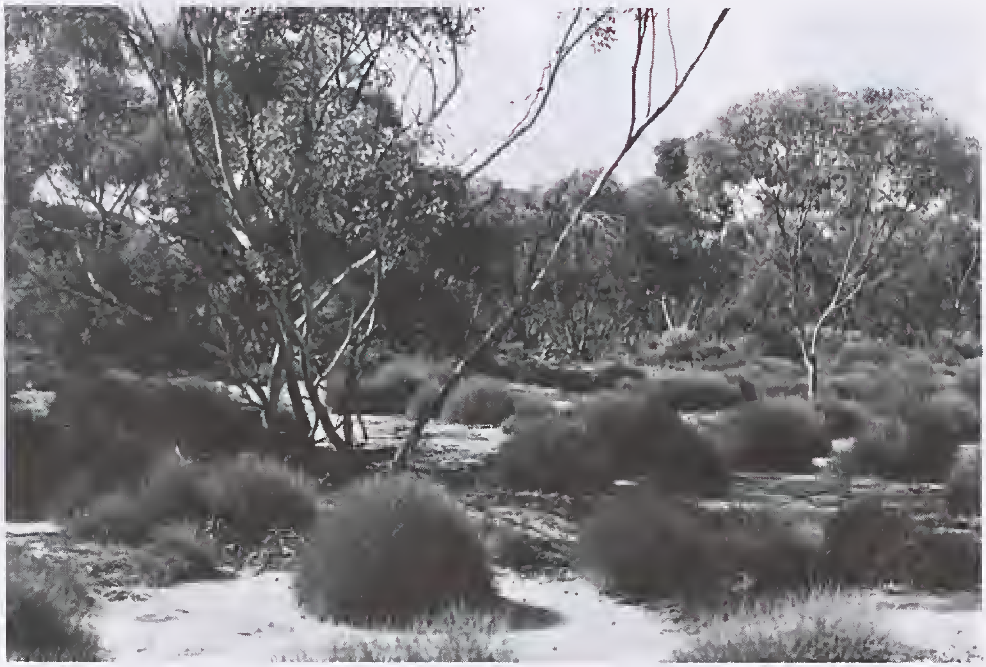

Fig 3. *Eucalyptus* shrubland with *Triodia scariosa* understorey is the most widespread community of the Scotia.

and herbs include *Stipa* spp., *Vittadinia cuneata, Dissocarpus paradoxus* and *Chenopodium cristatum.* There are few exotic species in this community.

2b *Eucalyptus gracilis/Melaleuca lanceolata* open-shrubland

In a narrow fringe around the salt lakes a mallee community to 8 m occurs in which *Melaleuca lanceolata* is a prominent component. Associated shrubs confined to this community include *Leptospermum coriaceum, Acacia rigens* and *Hibbertia virgata. Disphyma crassifolium* subsp. *clavellatum* is a common component of the ground layer.

2c *Eucalyptus* open-shrubland with *Triodia* understorey

On low dune ridges *Eucalyptus* open-shrubland to 8 m occurs and is characterised by the presence of *Triodia scariosa* as the dominant component of the understorey. The most frequent dominants are *Eucalyptus socialis, Eucalyptus dumosa* and *Eucalyptus gracilis* with *Eucalyptus oleosa, Eucalyptus costata* and *Eucalyptus leptophylla* as more occasional associates. Commonly associated shrubs include *Dodonaea viscosa* subsp. *angustissima, Maireana pentatropis, Eremophila glabra* and *Grevillea huegelii.* Associated grasses and herbs include *Stipa* spp., *Podolepis capillaris* and *Vittadinia cuneata.* There are few exotic species in this community (Fig.3).

2d *Eucalyptus porosa* low open-woodland

Adjacent to Canegrass tank on Tarawi is an area of *Eucalyptus porosa* low open-woodland growing to 8 m. The understorey includes the native species *Eremophila sturtii, Sclerolaena bicornis, Chenopodium cristatum* and *Zygophyllum ammophilum* with a number of exotics including *Brassica tournefortii, Solanum nigrum* and *Cucumis myriocarpus.*

3. Acacia shrublands

3a *Acacia aneura* open-shrubland

Small areas of *Acacia aneura* open shrubland to 8 m occur at a number of sites. They are generally surrounded by *Casuarina pauper* woodland. The understorey is dominated by herbs and grasses.

3b *Acacia loderi* open-shrubland

Several small areas of *Acacia loderi* open shrubland to 6 m occur, with an understorey dominated by herbs and grasses.

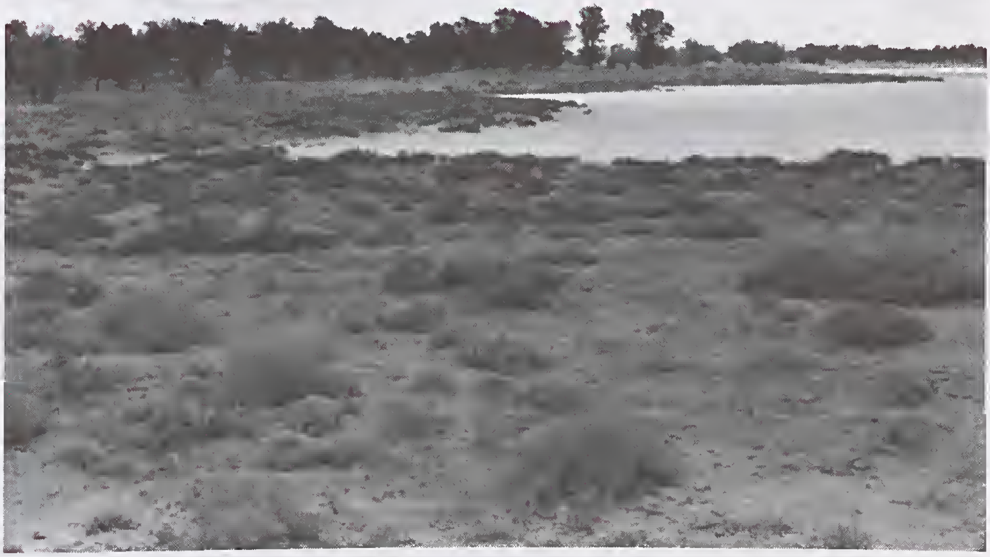

Fig. 4. The *Halosarcia/Frankenia/Osteocarpum* low open shrubland occurring around a number of salt lakes includes *Hemichroa diandra*, not previously recorded from NSW.

4. Low open shrublands

4a *Dodonaea viscosa* subsp. *angustissima*/ *Eremophila sturtii* shrubland/open-shrubland

In a number of areas *Dodonaea viscosa* subsp. *angustissima* and/or *Eremophila sturtii* form stands of varying density to approximately 2 metres. The understorey consists of a variety of grasses and herbs. This community is regarded as resulting from clearing of eucalypt open-shrubland or *Casuarina pauper* woodland.

4b *Maireana sedifolia* low open-shrubland

Occurring throughout the Scotia are areas of low open-shrubland dominated by *Maireana sedifolia*, with or without a sparse overstorey of *Casuarina pauper* or *Eucalyptus* spp. Low shrub associates include *Enchylaena tomentosa* var. *tomentosa* and *Sclerolaena obliquicuspis*. The ground layer includes *Vittadinia cuneata* and *Stipa* spp.

4c *Atriplex vesicaria* low open-shrubland

An open-shrub community dominated by *Atriplex vesicaria* is extensive around the salt lakes. Frequently associated species include *Lycium australe*, *Disphyma crassifolium* subsp. *clavellatum*, *Maireana pentatropis*, *Sclerolaena obliquicuspis* and *Stipa* spp.

4d *Halosarcia/Frankenia/Osteocarpum* low open-shrubland

Around the perimeter of many salt lakes is a community dominated by varying proportions of *Halosarcia pergranulata*, *Halosarcia indica*, *Halosarcia halocnemoides* subsp. *halocnemoides*, *Frankenia* sp. and *Osteocarpum acropterum* subsp. *diminutum* (Fig. 4).

4e *Halosarcia lylei* low open-shrubland

A near monospecific community of *Halosarcia lylei* occurs across the bed of smaller salt lakes and around the perimeter of larger lakes (Fig.5).

5. Grasslands/Herblands

5a *Eragrostis australasica* tussock grassland

Small patches of *Eragrostis australasica* grassland occur on isolated clay pans in the area. From the number of tanks carrying the Canegrass name it seems likely that this was once more widespread. Because sites supporting this community are suitable for the location of groundwater tanks, heavy grazing pressure has occurred leading to local elimination.

5b Herbland

An artificial community consisting of largely exotic grasses and herbs with no associated shrubs generally occurs around the more reliable groundwater tanks.

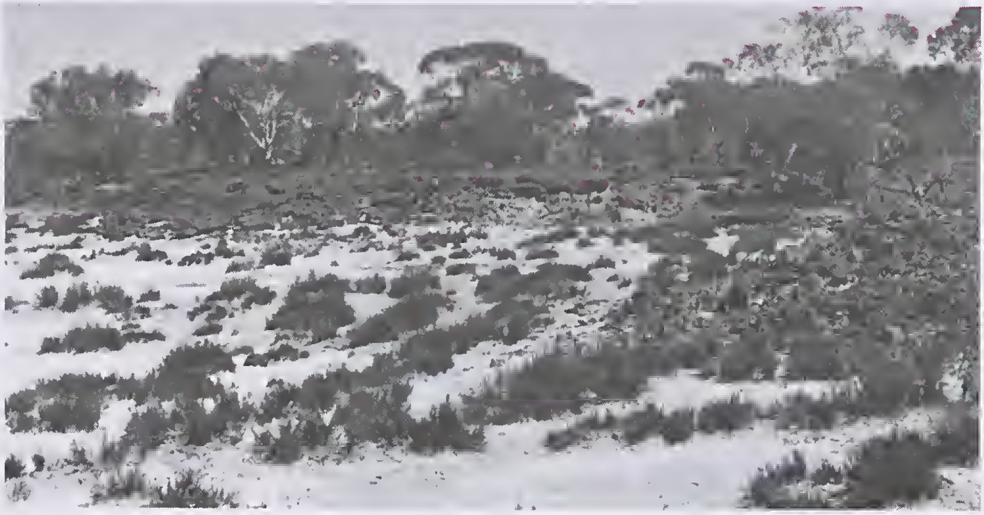

Fig. 5. *Halosarcia lylei* not previously recorded from NSW occurs as a near monospecific community around the larger salt lakes.

Distribution of communities

The distribution of communities is shown on the Scotia vegetation map.

Species

Three hundred and eighty vascular plant species from 66 families were recorded from the area including 62 (16%) exotics (Appendix 1). The weediness and species richness of each community is given in Table 1. A full listing of species is given as Appendix 1. Reference specimens are held at the University of Ballarat.

Discussion

The distribution of plant communities within the Scotia is largely determined by minor changes in topography and associated soil type. *Eucalyptus* open-shrubland with *Triodia scariosa* understorey occurs in sandy soils on the low dunes. *Eucalyptus* shrubland with a shrub understorey occurs in the swales. *Casuarina pauper* woodland occurs on calcareous plains of loamy solonised brown soils. *Atriplex vesicaria* low open shrubland is associated with the areas around the salt lake systems and on islands within the salt lakes, while *Halosarcia/ Osteocarpum/ Frankenia* and *Halosarcia lylei* low open-shrublands occur on the bed and around the fringes of salt lakes.

Conservation values

Significant communities

Halosarcia lylei low open-shrubland has not previously been recorded from NSW (Harden 1990–1993). Whilst the species is not listed as endangered for Australia (Briggs & Leigh 1995) this is the only site in NSW from which it has been recorded. *Halosarcia/Frankenia/Osteocarpum* low open-shrubland frequently includes *Hemichroa diandra* which also has not previously been recorded from NSW. This species is not listed as endangered for Australia (Briggs & Leigh 1995) but is endangered in Victoria (Gullan et al. 1990). Its widespread occurrence in this area is significant. *Eucalyptus porosa* is regarded as infrequent in NSW (Cunningham et al. 1981) and the presence of an extensive stand at Canegrass bore is significant. *Eragrostis australasicus* tussock grassland is at risk as long as high grazing pressure continues. Examples of this community in Hattah–Kulkyne National Park, north-west Victoria, did not recover following the removal of stock in 1980 and have only recovered following the reduction of kangaroo populations in the 1990s (D. Major, Dept. Natural Resources & Environment, pers. comm.).

Species richness of plant communities

Far more species were recorded in these surveys from both the *Casuarina pauper* open-woodland and the *Eucalyptus* shrubland communities than during studies of examples of the communities at Mungo National Park (Westbrooke & Miller 1996) and Mallee Cliffs National Park (Morcom & Westbrooke 1990). Whilst this may be due to variation in sampling effort and seasonal variation in herb species, it is likely to be a reflection of the relatively short grazing history of the Scotia. Comparative data are presented in Table 2. Also of note is the high total species richness (215) of the *Dodonaea viscosa* subsp. *angustissima/Eremophila sturtii* shrubland/open-shrubland (community 4a). This may reflect its derivation from more than one naturally occurring community.

Significant plant species

None of the species recorded is rare or threatened Australia-wide (Briggs & Leigh 1995) but nine have either not previously been recorded, or have restricted distribution in western NSW (Harden 1990–93). *Halosarcia lylei, Hemichroa diandra, Podotheca angustifolia* and *Elachanthus glaber* have not been recorded for NSW; *Bergia trimera* and *Ptilotus atriplicifolius* have not been recorded for the south far western province; *Cratystylis conocephala, Acacia acanthoclada* and *Kippistia suaedifolia* were previously known only from a few sites in NSW and were listed by Pressey (1993) as at risk. Beckers (1997) records *Cratystylis conocephala, Kippistia suaedifolia* and *Acacia acanthoclada* on Schedule 1, Part 1 endangered species for the Western Zone of NSW but does not list the other six species since they were not previously recorded for New South Wales. With the exception of *Acacia acanthoclada,* which is only found on low dune ridges within *Eucalyptus* open-shrubland with *Triodia* understorey, and *Cratystylis conocephala* and *Podotheca angustifolia,* which only occur within eucalypt shrublands, these species are associated with the salt lakes.

Table 2. Total species richness and mean percentage weediness of communities in the Scotia compared to Mungo and Mallee Cliffs National Parks

Location	**Total species richness**			**Mean % weediness**		
Community	**1a**	**2a**	**2c**	**1a**	**2a**	**2c**
Scotia	206	151	207	6	3	1
Mungo National Park	88	82	140	26	18	2
Mallee Cliffs National Park	62	62	74	11	3	5

Disturbance

Despite the relatively short grazing history of the area, direct and indirect impacts of pastoral activity are evident. Chaining (the clearing of overstorey trees by dragging a heavy chain between two bulldozers) was used extensively in the 1970s to improve pasture growth. Many of the areas of *Casuarina pauper* open-woodland treated in this way now carry *Dodonaea/Eremophila* shrubland (K. Borgholm, Ennisvale Station, pers. comm.). A large number of 'shot lines' were bulldozed in the 1980s during geological survey and are now notable for species such as *Halganea cyanea* and *Haloragis odontocarpa* which appear to be associated with fire and/or disturbance.

Eucalyptus shrubland is highly flammable and large areas were burnt in the wildfires of 1975/6 (Rodda 1978). Fire-promoted species such as *Codonocarpus cotonifolius* are now declining in these areas. Further areas on Tarawi and Nagalea leases were burnt experimentally during the 1980s to investigate the effects of burning on pasture (Noble

1989). In December 1996 three areas burned in wildfires including an area of a 1985 experimental burn. Areas of *Casuarina pauper* woodland, having a relatively non-flammable understorey, did not burn in these fires.

Exotic species

Sixty-two exotic species were recorded from the survey of which only two, *Nicotiana glauca* and *Lycium ferocissimum*, are woody perennials and only the latter is listed as a noxious weed (NSW Government 1997). The most frequently occurring exotic species are the grasses, *Schismus barbatus, Critesion murinum* subsp. *leporinum* and *Bromus rubens*. Exotic species recorded in 2% or more of quadrats are listed in Table 3. Weediness in all communities is significantly lower than that reported for Mungo National Park (Westbrooke & Miller 1996) and Mallee Cliffs National Park (Morcom & Westbrooke 1990) as shown in Table 2.

Table 3. Most frequently occurring exotic species in the Scotia.

Species	**% occurrence**
Schismus barbatus	11
Critesion murinum subsp. *leporinum*	7
Bromus rubens	5
Hypochoeris radicata	4
Medicago minima	4
Medicago polymorpha	3
Sonchus oleraceus	3
Centaurea melitensis	2
Dittrichia graveolens	2
Erodium cicutarium	2
Hypochoeris glabra	2
Onopordum acaulon	2
Reichardia tingitana	2
Solanum nigrum	2
Spergularia rubra	2

Conclusion

The Scotia contains highly significant plant communities not represented in conservation reserves, as well as some of the most intact examples of *Eucalyptus* spp. open-shrubland and *Casuarina pauper* woodland in New South Wales. The vegetation communities of south western NSW have until recently been poorly conserved and the communities associated with the Scotia are of particular significance due to their species richness, low weediness and occurrence of significant species. There has been some improvement to reservation with the purchase of the Tarawi lease to be gazetted as a Nature Reserve, which has provided some protection for large areas of *Eucalyptus* shrubland and *Casuarina pauper* woodland. The conservation reserves of south western NSW are shown in Fig. 6. Data on reservation of relevant vegetation types based on Freudenberger et al. (1997) is given in Table 4. It can be seen that even the more widely occurring communities are well below the target of 20% reservation proposed by Freudenberger et al. (1997) and a number of localised communities are unreserved.

Data from this survey suggest that, even without specific management strategies, pastoral properties with low stocking intensities are capable of providing refugia for biological diversity. It should however be noted in this case that the Scotia area has a relatively short grazing history and, due to the presence of large areas of mallee with a *Triodia* understorey and, until recently, restricted water supplies, stocking rates have been low. The advent of PVC pipe enabling cheap reticulation of water may change this and lead to elimination of such refugia through increased and more widespread stocking rates. This study highlights the need for detailed biological surveys, including the establishment of monitoring plots, to establish baselines against which change may be measured and to identify species and communities requiring reservation.

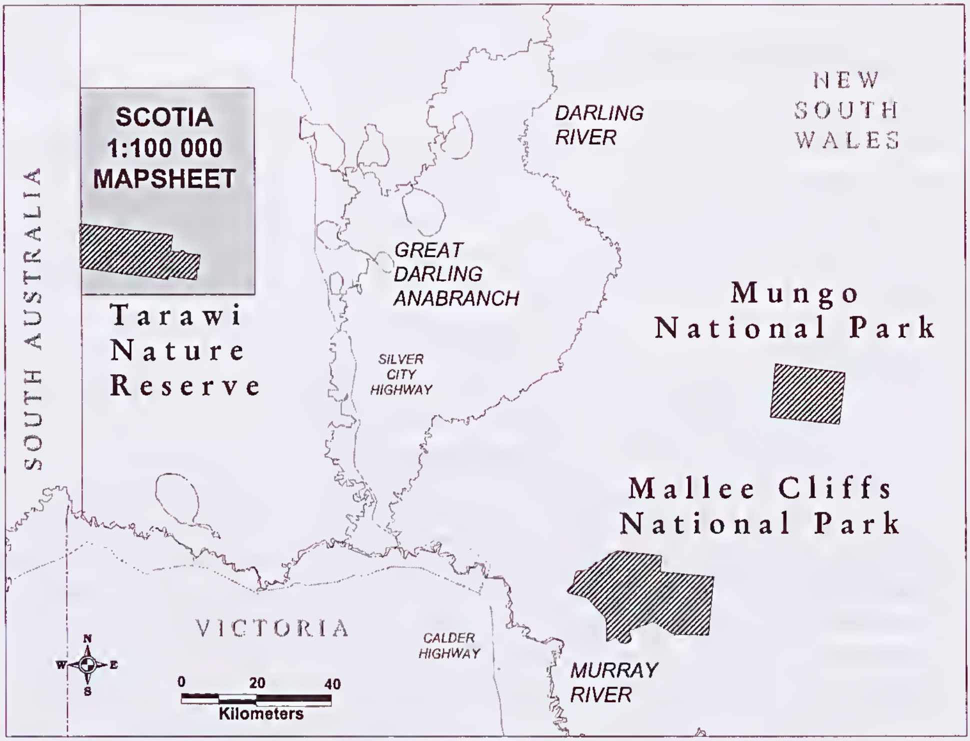

Fig. 6. Conservation reserves in south western NSW.

Table 4. Extent of reservation of Scotia vegetation types in south western NSW (includes proposed extensions to Mungo National Park)

Vegetation type	Area (km²)	% total area	% in reserves
1a *Casuarina pauper* woodland/open-woodland	9863	21	4
1b *Eucalyptus largiflorens* open-woodland	2298	5	< 1
1c *Callitris glaucophylla* open-woodland		Data not available	
1d *Hakea leucoptera* low open-woodland		Data not available	
1e *Hakea tephrosperma* low open-woodland		Data not available	
2a *Eucalyptus* spp. open-shrubland with shrub understorey (mosaic)	2389	5	12
2b *Eucalyptus gracilis/Melaleuca lanceolata,* open-shrubland	< 1	<1	0
2c *Eucalyptus* spp. open-shrubland with *Triodia* understorey	8082	17	10
2d *Eucalyptus porosa* low open-woodland	< 1	<1	0
3a *Acacia aneura* open-shrubland	< 1	<1	< 1
3b *Acacia loderi* open-shrubland		Data not available	
4a *Dodonaea/Eremophila* shrubland		Data not available	
4b *Atriplex vesicaria* low open-shrubland		Data not available	
4c *Halosarcia/Frankenia/Osteocarpum* low open-shrubland	< 1	<1	0
4d *Halosarcia lylei* low open-shrubland	< 1	<1	0
5a *Eragrostis australasica* tussock grassland	104	<1	0

Acknowledgments

This work was carried out under Licence A393 of the NSW National Parks & Wildlife Service. The assistance and hospitality of property owners during the course of this survey is gratefully acknowledged. In particular we wish to thank Trevor and Mignon Brown of Tarawi, Norm and Norma Scadding of Belvedere, Rob and Bev Taylor of Nanya, Geoff Rhodda of Nagalea and Wemba, Malcolm and Karen Hammat of Loch Lilly, Chris, Dorothy and Albi Wilhelm of Ennisvale/Tarrara and John Walmesley of Scotia Sanctuary. Special thanks are due to Rob Humphries, Nicky Taws, Larissa Westbrooke and Sue Hadden for technical assistance in the field, Matthew Gibson for assistance with map production and Peter Clark of the Department of Land & Water Conservation for assistance with the provision of baseline GIS data.

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Manuscript accepted 25 May 1998

APPENDIX 1

Vascular plant species recorded from the Scotia 1: 100 000 mapsheet. Nomenclature according to Harden (1990–1993)

Exotic species denoted thus *

ADIANTACEAE

Cheilanthes austrotenuifolia

AIZOACEAE

Disphyma crassifolium subsp. *clavellatum*

**Mesembryanthemum crystallinum*

**Psilocaulon tenue*

Tetragonia tetragonioides

ALSTROMERIACEAE

Dicrastylis verticillata

AMARANTHACEAE

Hemichroa diandra

Ptilotus sessifolius

Ptilotus erubescens

Ptilotus exaltatus

Ptilotus gaudichaudii

Ptilotus nobilis

Ptilotus obovatus

Ptilotus polystachyus

Ptilotus seminudus

Ptilotus atriplicifolius var. *atriplicifolius*

Ptilotus spathulatus

APIACEAE

Daucus glochidiatus

ASCLEPIADACEAE

Leichhardtia australis

Rhyncharrhena linearis

ASTERACEAE

Actinobole uliginosum

Angianthus spp.

Angianthus tomentosus

**Arctotheca calendula*

Brachyscome ciliaris

Brachyscome exilis

Brachyscome lineariloba

Brachyscome trachycarpa

Bracteantha bracteata

Calotis cymbacantha

Calotis erinacea

Calotis hispidula

**Carthamus lanatus*

**Centaurea melitensis*

Centipeda cunninghamii

Centipeda minima

Centipeda thespidioides

**Chondrilla juncea*

Chrysocephalum apiculatum s.l.

Chthonocephalus pseudevax

**Cirsium vulgare*

**Conyza bonariensis*

Cratystylis conocephala

**Dittrichia graveolens*

Elachanthus glaber

Eriochlamys behrii

Euchiton sphaericus

Gnephosis arachnoidea

Gnephosis tenuissima

**Hedypnois cretica*

Hyalosperma demissum

Hyalosperma stoveae

**Hypochoeris glabra*

**Hypochoeris radicata*

Isoetopsis graminifolia

Ixiolaena leptolepis

Kippistia suaedifolia

**Lactuca serriola*

Lemooria burkittii

Millotia greevesii

Millotia myosotidifolia

ASTERACEAE cont.

Minuria cunninghamii

Minuria intergerrima

Myriocephalus rhizocephalus

Myriocephalus stuartii

Olearia muelleri

Olearia pimeleoides

Olearia subspicata

**Onopordum acaulon*

Podolepis capillaris

Podotheca angustifolia

Pogonolepis muelleriana

Pseudognaphalium luteoalbum

Pycnosorus pleiocephalus

**Reichardia tingitana*

Rhodanthe corymbiflora

Rhodanthe microglossa

Rhodanthe moschata

Rhodanthe pygmaea

Rhodanthe stuartiana

Rhodanthe tietkensii

Senecio glossanthus

Senecio minimus

Senecio pinnatifolius

Senecio quadridentatus

Senecio runcinifolius

**Sonchus asper* s.l.

**Sonchus oleraceus*

Stuartina muelleri

Triptilodiscus pygmaeus

Vittadinia cuneata

Vittadinia dissecta

Waitzia acuminata var. *acuminata*

**Xanthium spinosum*

BORAGINACEAE

**Echium plantagineum*

Halgania cyanea

Heliotropium curassavicum

**Heliotropium europaeum*

**Heliotropium supinum*

Omphalolappula concava

Plagiobothrys plurisepalus

BRASSICACEAE

**Alyssum linifolium*

Arabidella trisecta

**Brassica tournefortii*

**Carrichtera annua*

Geococcus pusillus

Harmsiodoxa blennodioides

Harmsiodoxa brevipes var. *brevipes*

Lepidium leptopetalum

Lepidium papillosum

Lepidium phlebopetalum

Menkea australis

**Sisymbrium erysimoides*

**Sisymbrium irio*

**Sisymbrium orientale*

Stenopetalum lineare

Stenopetalum sphaerocarpum

CACTACEAE

**Opuntia vulgaris*

CAESALIPINACEAE

Senna artemisioides notho subsp. *coriacea*

Senna artemisioides subsp. *filifolia*

Senna artemisioides subsp. *petiolaris*

CAMPANULACEAE

Wahlenbergia communis s.l.

Wahlenbergia gracilenta s.l.

Wahlenbergia gracilis s.l.

CARYOPHYLLACEAE

Gypsophila tubulosa

**Herniaria cinerea*

Scleranthus minusculus

**Silene apetala*

**Spergularia diandra*

**Spergularia rubra*

CASUARINACEAE

Casuarina pauper

CHENOPODIACEAE

Atriplex acutibractea

Atriplex eardleyae

Atriplex holocarpa

Atriplex lindleyi subsp. *inflata*

Atriplex nummularia

Atriplex stipitata

Atriplex suberecta

Atriplex vesicaria

**Chenopodium album*

Chenopodium cristatum

Chenopodium curvispicatum

Chenopodium desertorum

Chenopodium melanocarpum

**Chenopodium murale*

Chenopodium nitrariaceum

Chenopodium spp.

Chenopodium ulicinum

Dissocarpus paradoxus

Einadia nutans

Enchylaena tomentosa var. *tomentosa*

Eriochiton sclerolaenoides

Halosarcia halocnemoides subsp. *halocnemoides*

Halosarcia indica

Halosarcia lylei

Halosarcia pergranulata

Halosarcia pterygosperma subsp. *pterygosperma*

Maireana appressa

Maireana brevifolia

Maireana ciliata

Maireana decalvans

Maireana erioclada

Maireana georgei

Maireana integra

Maireana lobiflora

Maireana pentatropis

Maireana pyramidata

Maireana radiata

Maireana sedifolia

Maireana trichoptera

Maireana triptera

Maireana turbinata

Malacocera tricornis

Neobassia spp.

Osteocarpum acropterum var. *deminutum*

Rhagodia spinescens

Rhagodia ulicina

Salsola kali

Sclerolaena bicornis

Sclerolaena decurrens

Sclerolaena diacantha

Sclerolaena divaricata

Sclerolaena muricata

Sclerolaena obliquicuspis

Sclerolaena parviflora

Sclerolaena patenticuspis

Sclerolaena tricuspis

Sclerostegia tenuis

CONVOLVULACEAE

Convolvulus erubescens

CRASSULACEAE

Crassula colorata

CUCURBITACEAE

**Citrullus colocynthis*

**Cucumis myriocarpus*

CUPRESSACEAE

Callitris glaucophylla

Callitris verrucosa

CYPERACEAE

Schoenus subaphyllus

DILLENIACEAE

Hibbertia virgata

ELATINACEAE

Bergia trimera

EUPHORBIACEAE

Beyeria opaca

EUPHORBIACEAE

Chamaesyce drummondii

Poranthera microphylla

FABACEAE

Daviesia ulicifolia

Eutaxia diffusa/microphylla

Indigophora australis

Lotus cruentus

**Medicago laciniata*

**Medicago minima*

**Medicago polymorpha*

**Melilotus indicus*

Swainsona purpurea

Templetonia egena

FRANKENIACEAE

Frankenia connata

Frankenia foliosa

Frankenia pauciflora subsp. *pauciflora*

Frankenia serpyllifolia

GENTIANACEAE

**Centaurium spicatum*

**Centaurium tenuiflorum*

GERANIACEAE

**Erodium botrys*

**Erodium cicutarium*

Erodium crinitum

GOODENIACEAE

Goodenia fascicularis

Goodenia pinnatifida

Goodenia pusilliflora

Scaevola depauperata

Scaevola spinescens

GYROSTEMONACEAE

Codonocarpus cotinifolius

HALORAGACEAE

Glischrocaryon behrii

Haloragis aspera

Haloragis odontocarpa

Myriophyllum verrucosum

Myriophyllum sp.

JUNCAGINACEAE

Triglochin calcitrapum

LAMIACEAE

**Marrubium vulgare*

**Salvia verbenaca*

Teucrium racemosum var. racemosum

Westringia rigida

LAURACEAE

Cassytha melantha

LILIACEAE

Bulbine bulbosa

Dianella revoluta

Thysanotus baueri

LOGANIACEAE

Logania nuda

LORANTHACEAE

Amyema linophyllum subsp. *orientale*

Amyema miquelii

Amyema miraculosum subsp. *boormanii*

Amyema preissii

Lysiana exocarpi subsp. *exocarpi*

MALVACEAE

Abutilon fraseri

Lawrencia glomerata

Lawrencia squamata

**Malva parviflora*

**Modiola caroliniana*

Radyera farragei

Sida corrugata var. corrugata

Sida intricata

MARSILEACEAE

Marsilea angustifolia

Marsilea costulifera

Marsilea drummondii

MIMOSACEAE

Acacia acanthoclada

Acacia aneura

Acacia brachybotrya

Acacia burkittii

Acacia colletioides

Acacia ligulata

MIMOSACEAE cont.

Acacia loderi

Acacia oswaldii

Acacia rigens

Acacia sclerophylla

Acacia wilhelmiana

MYOPORACEAE

Eremophila deserti

Eremophila divaricata subsp. *divaricata*

Eremophila glabra

Eremophila glabra subsp. *murrayana*

Eremophila longifolia

Eremophila maculata var. *maculata*

Eremophila oppositifolia subsp. *oppositifolia*

Eremophila scoparia

Eremophila sturtii

Myoporum platycarpum

Myoporum viscosum

MYRTACEAE

Baeckea crassifolia

Eucalyptus costata/incrassata

Eucalyptus dumosa

Eucalyptus gracilis

Eucalyptus leptophylla

Eucalyptus oleosa

Eucalyptus porosa

Eucalyptus socialis

Leptospermum coriaceum

Melaleuca lanceolata

NYCTAGINACEAE

Boerhavia dominii

OLEACEAE

Jasminum didymum subsp. *lineare*

ORCHIDACEAE

Pterostylis biseta s.l.

OXALIDACEAE

Oxalis perennans

**Oxalis pes-caprae*

PITTOSPORACEAE

Billardiera cymosa

Pittosporum phylliraeoides

PLANTAGINACEAE

Plantago cunninghamii

Plantago drummondii

Plantago varia

POACEAE

Agrostis avenacea

Amphipogon caricinus var. *caricinus*

Aristida contorta

Aristida spp.

Bromus arenarius

**Bromus rubens*

Chloris truncata

**Critesion murinum* subsp. *leporinum*

Cynodon dactylon

Danthonia eriantha

Danthonia setacea

Enneopogon intermedius

Eragrostis australasica

Eragrostis dielsii

Eragrostis eriopoda

Eragrostis falcata

Eragrostis setifolia

**Holcus lanatus*

**Panicum capillare*

Paspalidium gracile

**Rostraria pumila*

**Schismus barbatus*

Stipa drummondii

Stipa elegantissima

Stipa scabra subsp. *scabra*

Stipa spp.

Triodia scariosa subsp. *scariosa*

**Vulpia myuros*

POLYGONACEAE

**Emex australis*

Muehlenbeckia diclina

POLYGONACEAE cont.

Muehlenbeckia florulenta

Polygonum plebeium

**Rumex crispus*

Rumex tenax

PORTULACACEAE

Calandrinia eremaea

PRIMULACEAE

**Anagallis arvensis*

PROTEACEAE

Grevillea huegelii

Grevillea pterosperma

Hakea leucoptera

Hakea tephrosperma

RANUNCULACEAE

Ranunculus pumilio

RHAMNACEAE

Cryptandra propinqua

RUBIACEAE

Asperula conferta

Synaptantha tillaeaceae

RUTACEAE

Geijera parviflora

SANTALACEAE

Exocarpos aphyllus

Exocarpos sparteus

Santalum acuminatum

SAPINDACEAE

Alectryon oleifolius subsp. *canescens*

Dodonaea bursariifolia

Dodonaea viscosa subsp. *angustissima*

SCROPHULARIACEAE

Limosella australis

Morgania floribunda

SOLANACEAE

Duboisia hopwoodii

Lycium australe

**Lycium ferocissimum*

**Nicotiana glauca*

Nicotiana goodspeedii

Nicotiana occidentalis

Nicotiana simulans

Nicotiana velutina

Solanum coactiliferum

Solanum esuriale

**Solanum nigrum*

THYMELAEACEAE

Pimelea microcephala subsp. *microcephala*

Pimelea simplex subsp. *simplex*

Pimelea trichostachya

TYPHACEAE

Typha domingensis

URTICACEAE

Parietaria debilis

VERBENACEAE

**Verbena supina*

XANTHORRHOEACEAE

Lomandra effusa

Lomandra leucocephala subsp. *robusta*

ZYGOPHYLLACEAE

Nitraria billardierei

Tribulus terrestris

Zygophyllum ammophilum

Zygophyllum apiculatum

Zygophyllum aurantiacum

Zygophyllum billardieri

Zygophyllum crenatum

Zygophyllum eremaeum

Zygophyllum glaucum

Zygophyllum iodocarpum

Zygophyllum ovatum

An inventory of host species for each aerial mistletoe species (Loranthaceae and Viscaceae) in Australia

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Downey, Paul Owen (Centre for Plant Biodiversity Research, CSIRO Plant Industry, GPO Box 1600 Canberra, ACT 2601. Present Address CRC for Weed Management Systems, CSIRO Entomology, GPO Box 1700 Canberra, ACT 2601, paul.downey@ento.csiro.au) 1998. An inventory of host species for each aerial mistletoe species (Loranthaceae and Viscaceae) in Australia. Cunninghamia *5(3): 685–720.* The present study catalogues the host taxon (to species level) for each of the 88 aerial mistletoe species in Australia, including Norfolk and Lord Howe Islands. A dataset was compiled of Australian loranthaceous and viscaceous species housed in nine major Australian herbaria viz. Adelaide, Atherton, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth and Sydney. Labels from 11 958 herbarium specimens were examined, of which 9542 contained host information, with 7325 documented to species level. All host names were checked for synonymy, to provide as 'clean' a dataset as possible. A total of 873 host species was documented from 256 genera and 79 families. The number of host species recorded per mistletoe species ranged from no recorded host species to 125. The number of host species in each genus ranged from 1 to 187 (*Eucalyptus*). The dataset provides the most complete baseline catalogue of the host species for each aerial mistletoe species in Australia.

Introduction

The term 'parasite' refers to either a plant or an animal which depends on another organism, its host, for nutrition. The parasite and host co-exist in an obligatory association in which the parasite depends metabolically on the host, during a particular stage or throughout its entire life cycle (Krebs 1994). In the vascular plant kingdom an estimated 3000 species or 1% of the flowering plants are considered to be parasitic (Kuijt 1969; Atsatt 1983), of which approximately 1400 species are classified as mistletoes. These shrubby aerial hemi-parasites (and several species of terrestrial root-parasites) are distributed among five families viz. Loranthaceae, Viscaceae, Misodendraceae, Eremolepidaceae and Santalaceae (Kuijt 1969). Mistletoe species are present on every continent except Antarctica, while their greatest diversity and variety is in tropical regions.

In Australia there are 90 species of mistletoes (Barlow 1996) distributed over the entire mainland, while none are present in Tasmania. Seventy-four of these species are in the family Loranthaceae, and the remaining 16 are in the family Viscaceae. Approximately 85% of the Australian loranthaceous (Barlow 1984a) and 50% of the Australian viscaceous (Barlow 1984b) mistletoe species are considered to be endemic. Two loranthaceous species are terrestrial root-parasites viz. *Nuytsia floribunda* and *Atkinsonia ligustrina* (Barlow 1984a). As the haustorial connection of these terrestrial root-parasites is located on their roots (which parasitise the roots of their hosts), it is difficult to establish the identity of their host species. Thus these two loranthaceous root-parasitic mistletoe species were excluded from the present study, leaving a total of 88 aerial mistletoe species.

Taxonomically, the Australian mistletoe species are well known as a result of studies by Barlow (1966, 1984a, b, 1996). However, there are limited published data on their hosts (see Blakely 1922a, b, 1923; Johri & Bhatnagar 1972). The information that has been published has traditionally described mistletoe hosts to genus, family or life form (e.g. exotic trees, rainforest trees, or simply as a wide variety of hosts), rarely to species level (see Barlow 1984a, b). For example, *Amyema miquelii* is considered to have 'many host species in the genus *Eucalyptus*' (Barlow 1984a, p. 111). *Eucalyptus* is a large genus of approximately 700 species (Brooker & Kleinig 1994), thus the description of hosts simply as *Eucalyptus* sp. is inadequate and uninformative.

In Australia, there has never been a comprehensive attempt to establish an inventory of the host species for any mistletoe species. The aim of the present study is to establish a baseline inventory of the known host taxa (to species level) for each of the 88 aerial mistletoe species in Australia (including Norfolk and Lord Howe Islands). It is hoped that this paper will stimulate a systematic documentation of the host species of these fascinating plants.

Methods

Major Australian herbaria, viz. Adelaide (AD), Atherton (QRS), Brisbane (BRI), Canberra (CANB), Darwin (DNA), Hobart (HO), Melbourne (MEL), Perth (PERTH) and Sydney (NSW) and the Australian Botanical Liaison Officer (ABLO) at Kew Herbarium (K), London, provided information on the total number of Australian loranthaceous (excluding the terrestrial root-parasites *Nuytsia floribunda* and *Atkinsonia ligustrina*) and viscaceous mistletoe specimens in their collections (ABLO provided the number of collections made by foreign botanists as well as the number of early Australian collections for which there are no duplicates in Australian herberia). The number of collections in databases, the amount of host information each specimen contained, and whether the host names were in databases were also documented.

After assessing the initial replies, a formal request was made to each herbarium to provide access to their label database, either electronically (on disk) or in hard copy. All specimens which were not on electronic databases were physically examined and the relevant information recorded. This entailed visits to AD, MEL and NSW. BRI was visited despite the entire collection being on database, as the database does not have the capability to hold host names. The specimens at HO were loaned to CANB. As very few collections held at K contained relevant information, they were not considered further.

Where visits were made to herbaria, every specimen was individually observed and the mistletoe species name and host species name or common name were recorded.

Duplicate collections were only recorded once. Any mistletoe specimen which the author considered to be incorrectly identified, was determined using Barlow's keys (1984a, b, 1992, 1993).

If a herbarium collection (either observed or on database) did not contain a host name or the mistletoe could not be easily identified to species level, then the collection was not used. Collections which referenced the host species as a separate collection for which the name was not recorded, were ignored, as collection numbers could not easily be traced.

Host names were checked for spelling mistakes using Hnatiuk (1990). Common names were transcribed into scientific ones using Hartley (1979) and Lazarides & Hince (1993). Each host name was checked for synonymy using Hnatiuk (1990) and Chapman (1991a, b, c, d). Eucalypt nomenclature followed Brooker & Kleinig (1983, 1990, 1994), *Melaleuca* and *Syzygium* host names were checked by L.A. Craven (*Melaleuca* and *Syzygium* authority). Mistletoe nomenclature followed Barlow (1984a, b, 1992, 1993, 1996). Host nomenclature problems were resolved with relevant treatments in the *Flora of Australia*, including Wilson & Johnson (1989) and Chippendale (1988), regional floras including Harden (1990, 1991) and Jessop & Toelken (1986a, b), and specialist texts like Whibley & Symon (1992). The family name of each host species was also recorded with the help of Brummitt (1992).

As no host name was determined as a species of *Corymbia* (Hill & Johnson 1995) at the time of collation, *Eucalyptus* applies to all eucalypt host species. Host records determined to genus level which had subsequently been split into two or more genera, could not be distinguished. For example, the genus *Casuarina* has been split into *Casuarina* and *Allocasuarina* (Wilson & Johnson 1989). Hosts determined to *Casuarina* sp. could be either *Casuarina* sp. or *Allocasuarina* sp. (the distribution data was used to help determine some host species, in this group, as well as in others (where possible), otherwise they were left as their original collection determination). Without a specimen, the host's identity cannot be resolved.

Results

Of the 11 958 herbarium records, 7148 specimens were physically observed. Information for the remaining 4810 collections was obtained from databases; these specimens were not observed, thus the determinations were not checked by the author. Of the total, 9542 collections contained host names, of which 7325 were determined to species level, the remaining 2217 were only determined to genus level.

At least one specimen of all 88 described aerial mistletoe species (Barlow 1996) was examined. The total number of collections for each mistletoe species ranged from 1 (*Amyema subcapitata*) to 919 (*Amyema miquelii*) (Appendix 1).

Some 873 species belonging to 256 genera, and 79 families were recorded as mistletoe hosts. Of the 256 genera, 22 did not contain host records determined to species level, e.g. *Baeckea* sp. An additional 56 genera contained host records determined to genus as well as to species rank. The remaining host genera were all determined to species rank.

The number of host species recorded per mistletoe species ranged from zero (no hosts recorded) to 125. For five mistletoe species no host species were recorded, viz. *Amyema friesiana*, *Amyema quaternifolia*, *Amyema seemeniana*, *Amyema subcapitata* and *Korthalsella grayi*. The number of records for each host species ranged from 1 to 412 (*Acacia aneura*). The number of host species in each genus ranged from 1 to 187 (*Eucalyptus*). The frequency of host-mistletoe combinations varied considerably, from 1 to 137 (*Amyema maidenii* on *Acacia aneura*).

Host plants were mostly dicotyledonous angiosperms, although there was a small number of gymnosperms in the genera *Araucaria*, *Callitris* and *Pinus** (* denotes exotic species). No host species were herbaceous (as expected of woody aerial parasites), although many of the host genera contain herbaceous species. Every host family and genus recorded contained species which were not documented as mistletoe host species.

The two major genera of host species were *Eucalyptus* and *Acacia* with 2084, and 2559 records respectively. There were 187 species of *Eucalyptus* and 150 species of *Acacia* recorded.

Seven mistletoe species commonly parasitised exotic host species, viz. *Amyema congener*, *Dendrophthoe glabrescens*, *Dendrophthoe vitellina*, *Lysiana exocarpi*, *Lysiana subfalcata*, *Muellerina celastroides* and *Muellerina eucalyptoides* (see Appendix 1). Several other mistletoe species parasitised exotic hosts, but not as commonly. The commonly recorded exotic host species included *Nerium oleander**, *Citrus* spp.*, *Prunus* spp.*, *Schinus areira**, and *Quercus* spp.*

Discussion

The current catalogue of host species indicates the great diversity of plant species which can be parasitised. In addition, the compilation of the current lists allows objective questioning of terms like host-specificity and mimicry to be undertaken (Downey & Gill in prep.). The term host-specificity as put forward by Barlow & Wiens (1977) gives no indication of the number of host species a host-specific mistletoe parasitises. Despite this, the authors (Barlow & Weins 1997) described several host-specific mistletoe species, based on a limited list of host species (drawn from personal observations and a subset of herbarium collections). From this they used the dominant host species to discuss the concept of vegetative mimicry in Australian loranthaceous mistletoes. Downey & Gill (in prep.) used the current lists in an investigatation of host-specificity and found that few mistletoe species were specific in terms of their host species (with a host-specialist mistletoe species parasitising < 10 host species). Only three mistletoe species, viz. *Amyema cambagei*, *Amyema linophylla* and *Amyema melaleucae*, had high numbers of host records but few host species (see Appendix 1). Two of these have terete leaves. Mistletoe species with terete leaves exhibit a high degree of mimicry (Calder 1983). Downey & Gill (in prep.) question the concept of mimicry based on a more comprehensive list of host species than those used by Barlow & Wiens (1977) and suggest that crypsis is a more appropriate term. Attempts to question these terms in the past have resulted in some ambiguities (Atsatt 1983).

Mistletoe species that were previously documented as having a host-specific relationship with a particular host species, for example *Amyema lucasii* on *Flindersia maculosa* (Barlow & Wiens 1977; Barlow 1984a), highlight how a limited data set can bias our understanding. *Amyema lucasii* has six other documented host species (Appendix 1), questioning the validity of its documented high level of host-specificity (*Amyema lucasii* exhibits host preference for *Flindersia maculosa* rather than host-specificity).

Additional terms like host range, host preference and host selection have also been applied to mistletoe species (Musselman & Press 1995). These terms imply that we have a good understanding and knowledge of host species and the interaction between mistletoe species and their entire host range. However our understanding of the interactions between parasitic angiosperms and their host species trails behind that of other plant symbiotic associations (Musselman & Press 1995). A recent study of three mistletoe species in South Africa (Dean et al. 1994) documented 33 major host genera from 22 families, suggesting that our knowledge of host species is incomplete. *Amyema benthamii* was previously documented as growing on *Brachychiton* (Barlow 1984a). *Brachychiton* comprises one of 28 genera and 3 of 31 host species, from 20 families (see Appendix 1). Barlow (1984a, p. 95) states that '*Amyema friesiana* is parasitic on a wide range of host trees', however not one of them has been recorded (see Appendix 1). Only with a better understanding of host species can we objectively start to question these terms (Downey & Gill in prep.). Appendix 1 provides comprehensive and extensive information on host species for each of the 88 mistletoe species throughout their distribution. This level of information has not previously been collated for any of the Australian mistletoe species.

Herbarium records proved to be a beneficial starting point for the study of mistletoe host species. However, they do not provide a complete picture of the plant species that are parasitised by mistletoes. An investigation of mistletoe hosts in south-eastern Australia (Downey 1996), combined with subsequent adhoc collections made by the author (Downey unpubl. data), have revealed several host species not recorded in Appendix 1, suggesting that the collection of Australian mistletoe host species is, in general, inadequate. In addition, there are several inherent problems with using herbarium data for this kind of study, which include: misidentification of host specimens; no voucher specimen for the host species (in the majority of cases); synonymy within host names; no host information at all (see *Amyema seemeniana*, Appendix 1); and/or vague host information (e.g. to genus level, see *Dactyliophora novaeguineae*, Appendix 1). Despite this, the present study based on herbarium records provides an invaluable baseline, to a level never before achieved.

Few mistletoe collections (the exact number was not recorded) contained an actual host specimen. The majority of host specimens came from recent collections. Some (again the exact number was not recorded) were separate collections, the identity of which often could not be checked as they were not on a database. The majority of host information was simply in the form of collectors' notes. The accuracy of these cannot be verified because of the vast number of collectors and their areas of expertise. Thus, it is imperative that botanists collect host specimens for both epiphytes and parasites. The accuracy of any determination depends largely on the keys available, and its subsequent curation depends on the expertise of the herbarium staff. Irrespective of this the data contained within museums (herbaria) provides paramount information for ecological studies and decision-makers, which would not otherwise be available (Davis 1996).

The lack of a separate field containing the host species of parasitic plants on either herbarium labels or databases made the compilation of information difficult (see Downey 1996). The allocation of a separate field to encompass host names is a high priority, for mistletoes as well as epiphytic species. A mechanism to enable easy and quick access of host information would be beneficial (M. Clements pers. comm.).

The number of mistletoe collections could bias the number of host species recorded. For example, 8% (or 11 species) of mistletoe species had < 10 collections nationally, this number rose to approximately 33% (or 29 species) when the number of collections was increased to < 20. In addition, approximately half (47) the mistletoe species had < 10 host species, the majority of which had either limited distributions and/or few collections (e.g. *Viscum bancroftii* and *Muellerina myrtifolia*) (see Downey 1996). Despite this, there was a strong positive correlation between the number of mistletoe collections per species and the number of host species recorded for each mistletoe species (Downey & Gill in prep.). This suggests that additional host species will be uncovered as more collections are made (especially if collectors collect the host specimen), across all mistletoe species, as illustrated by Downey (1996).

When host-mistletoe combinations were investigated from the host species perspective approximately half of the host species formed combinations with only one mistletoe species. Many of these were single occurrences (Downey & Gill in prep.), suggesting that the present lists are by no means definitive.

The early knowledge of mistletoe host species in Australia was based on a subset of herbarium collections (Blakely 1922a, b, 1923, 1924, 1925), which were later compiled into lists (see Johri & Bhatnagar 1972). Their (Johri & Bhatnagar 1972) lists were a compilation of host species per mistletoe genus, which might imply there is no difference in terms of host preference between the mistletoe species in each genus. However, there is great variation in host preference within each mistletoe genus, for example *Amyema mackayense* parasitises mainly mangrove species while *Amyema miquelii* parasitises mainly *Eucalyptus* species (see Appendix 1). However, several taxonomically close mistletoe species shared many similar host genera viz. *Lysiana spathulata* and *Lysiana subfalcata* (Appendix 1). This could be a result of their distribution (both host and mistletoe) (Downey 1996). Studies by Downey et al. (in prep.) suggest a relationship between mistletoe distribution and the presence of potential host species, but information on host species and their distribution was insufficient to establish any relationship.

In Australia, the common misconception is that the only mistletoe host species are members of the genera *Eucalyptus* and *Acacia*. They are only two, albeit the largest, of 256 host genera, but they comprise nearly half the host records. One reason for this may be the sheer number of species in each (approximately 700 and 800 respectively) and their presence in every Australian landscape (Barlow 1981).

The role host species play in this parasitic interaction is rarely considered to be important. However, the host species may play a role in determining its parasitic constituents, through host resistance to haustorial penetration (Kuijt 1969; Yan 1993a) and chemical incompatibility (Kuijt 1969). There is a considerable number of plants which are not host species, besides the obvious herbaceous and annual species, which are incapable of sustaining mistletoes due to their growth forms and size.

Amyema miquelii had the greatest number of host species (125), just over a third of the number of host species recorded for *Dendrophthoe falcata* (343) in India (Johri & Bhatnagar 1972). In Europe *Viscum album* parasitises 230 host species, of which 186 are introduced trees (Hawksworth 1983). Johri & Bhatnagar (1972) claim that there is hardly any tree or shrub which is immune to mistletoe attack. However, many plant species are free from mistletoe infestation. The species parasitised may be attributable to the presence of both mistletoe and host species in any one location. For example, in Australia few gymnosperms are host species, but in the USA they are heavily infested (Hawksworth 1983). In India, trees which contain resinous sap are comparatively free of mistletoe infestation, when compared to trees which contain 'milky' sap (Fischer 1926). The current study found that few host species contained resinous sap, while many Apocynaceae species (many species of which contain 'milky' sap) were mistletoe hosts. Docters van Leeuwen (1954) could give no reason why trees with 'milky' sap were heavily infested while trees which were considered suitable hosts were unparasitised. The answers may be attributed to the physiological interaction between the host and mistletoe species (Hoffmann et al. 1986). A recent study of mistletoe hosts in South Africa showed that the nitrogen content of the host species may be an important host selection factor (Dean et al. 1994). Additionally, the authors suggest that host selection may be unrelated to the growth form of the host, with the exception of herbaceous plants. Downey et al. (1997) found that host attributes, including the height and canopy area of eucalypts, may play an important role in aiding mistletoe colonisation.

Birds are considered the primary source of mistletoe dissemination (Docters van Leeuwen 1954; Kuijt 1969). In Australia, the Mistletoe-bird (*Dicaeum hirundinaceum*) is considered the major disseminator (Liddy 1983). There are however, several other frugivorous bird species e.g. the Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*), which are also considered important mistletoe disseminators in Australia (Reid 1989, 1990; Yan 1993b). The Painted Honeyeater (*Grantiella picta*) is also noted to disperse mistletoes but may not be as important due to its rarity (Liddy 1983). Frugivorous birds are 'paid in advance' so there is no incentive to void seeds in an appropriate site for germination (Wheelwright & Orians 1982). Thus, mistletoe dissemination by frugivores to a potential host is to some extent a random event. How this influences host range is not clearly understood, but some authors (e.g. Blakely 1922a) have suggested that the occurrence of mistletoes on 'unusual' hosts is attributed to minor disseminators.

The presence of mistletoe species on exotic plant species suggests that some mistletoe species are highly opportunistic and can parasitise plant species which they have never encountered previously (Downey 1996). Endemism does not prevent mistletoe species from parasitising exotic host species, as both endemic and non-endemic mistletoe species have been recorded growing on exotic host species. The degree to which endemism plays a role in host colonisation needs further study. The ability of some mistletoe species to colonise exotic trees questions the nature of host-specificity. Is host-specificity an artefact of the tree species present in a given location? Species with large distributions exhibit low host specialisation (Downey & Gill in prep.). Seebeck (1997) raises many questions about the interaction between mistletoes and their exotic host species, highlighting our need to better understand this aspect of mistletoe parasitism. The author (Seebeck 1997) described four exotic host species which were not documented in the national data set viz. *Betula pendula**, *Plantanus x acerifolia**, *Quercus palustris**, *Ulmus parvifolia**.

Some mistletoe species possess the ability to grow on other mistletoe species (hyper-parasitism). Three Australian mistletoe species commonly hyper-parasitised other mistletoe species viz. *Amyema miraculosa*, *Notothixos subaureus* and *Viscum articulatum* (see Appendix 1). The reasons for this parasitic interaction are not clearly understood, one reason maybe attributable to the lack of other potential host species in a particular area (Downey pers. obs.). Hyper-parasitism also occurs within species, the occurrence of which maybe actually much higher than is recorded, as it would appear like one individual of that species, not two (B. Barlow pers. comm.). The ecological significance of hyper-parasitism and the pressures hyper-parasites place on their parasite hosts are poorly understood.

It is hoped that the compilation of these lists will generate interest in mistletoe host species in Australia. This in turn would result in more appropriate collections of mistletoe host species, while a better understanding of host species and their distribution will allow investigation of the role of host distribution in limiting or aiding the distribution of mistletoe species (Downey et al. in prep.).

Conclusion

Until now the knowledge of host species for each of the 88 aerial Australian mistletoe species has been poor. The present study provides a baseline catalogue of host species per mistletoe species on a national scale. However, herbarium information is a conglomeration of many different collectors, each of whom collected varying amounts of host information. It is imperative that herbarium specimens contain host information. Currently host information is based on collections of mistletoes rather than collections of host species per se.

The current study has established a baseline for the study of host-mistletoe combinations in Australia. However, the present study is incomplete, five mistletoe species have no documented host species, and the information for several mistletoe species is based on only a few collections.

Not all woody plant species are parasitised by mistletoe species in Australia. In fact no entire genus or family is parasitised. The number and taxonomic diversity of host species for each mistletoe species were found to vary considerably. Several mistletoe species opportunistically parasitised exotic species as well as native species, the significance of which is poorly understood. Several taxonomically close mistletoe species shared many common host genera however, this could be a result of the distribution of both host and mistletoe. Future studies allude to a relationship between mistletoe distribution and host species. However, a better understanding of host species and their distribution is needed.

Australian herbaria need to address the problems which have arisen from this study. Host names for parasitic as well as epiphytic plants should be incorporated into specimen electronic databases.

Acknowledgments

The author wishes to thank Malcolm Gill for his support and comments on an earlier manuscript and John Banks, Bryan Barlow and Peter Moore for their support throughout the study. The following people helped in various ways for which the author is grateful: Laurie Adams, Ian Brooker, Jermey Burdon, John Connors, Lyn Craven, Suzie Dietrich, Helen Hewson, Andrew Lyne, Jo Palmer, Chris Puttock, Andrew Slee, Ian Telford, Frank Udovivic, Judy West, Barbara Whitehead, Tim Woodburn and Nick Reid for his comments on an earlier manuscript. The Australian National University Department of Forestry provided financial assistance for herbaria visits.

The author gratefully acknowledges the Directors of the following herbaria: AD, BRI, CANB, DNA, HO, MEL, PERTH and NSW, for permitting the use of specimen data (Loranthaceae and Viscaceae) in their collections. The help of herbarium staff members who assisted with herbaria visits and in the provision of electronic data was greatly appreciated. Bob Makinson (ABLO) (K) assisted by investigating the number of loranthaceous and viscaceous specimens housed overseas. Clyde Dunlop (DNA) and Arthur Chapman from the Environmental Resources Information Network (ERIN) helped with the acquisition of electronic specimen data from DNA.

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Manuscript accepted 8 May 1998

Appendix 1. Host species for each mistletoe species in Australia. The numbers after each mistletoe species represents the total number of collections and the number of host species (to species level) recorded, respectively.

(* = exotic species)

LORANTHACEAE

Amyema benthamii **163 31**

Anacardiaceae
Buchanania sp.
Apocynaceae
Carissa lanceolata
Nerium oleander *
Asclepiadaceae
Marsdenia cinerascens
Caesalpiniaceae
Lysiphyllum cunninghamii
Celastraceae
Denhamia obscura
Combretaceae
Lumnitzera littorea
Terminalia canescens
Terminalia platyphylla
Cupressaceae
Callitris verrucosa
Euphorbiaceae
Croton sp.
Mallotus nesophilus
Petalostigma banksii
Mallotus quadriloculare
Lauraceae
Cryptocarya exfoliata
Loranthaceae
Lysiana spathulata
Meliaceae
Owenia reticulata
Owenia vernicosa
Mimosaceae
Acacia delibrata
Acacia orthocarpa
Acacia tumida
Acacia victoriae
Moraceae
Ficus coronulata
Ficus opposita
Myrtaceae
Eucalyptus sp.
Proteaceae
Banksia dentata
Grevillea sp.
Hakea sp.
Rubiaceae
Aidia cochinchinensis
Gardenia sp.
Sapindaceae
Atalaya hemiglauca
Sapotaceae
Planchonella arnhemica
Sterculiaceae
Brachychiton australis
Brachychiton gregorii
Brachychiton obtusifolius
Brachychiton populneus
Tiliaceae
Grewia breviflora

Amyema bifurcata **216 29**

Mimosaceae
Acacia acuminata
Myrtaceae
Angophora costata
Angophora melanoxylon
Angophora woodsiana
Angophora floribunda
Angophora subvelutina
Eucalyptus aspera
Eucalyptus bleeseri
Eucalyptus camaldulensis
Eucalyptus cliftoniana
Eucalyptus confertiflora
Eucalyptus foelscheana
Eucalyptus gummifera
Eucalyptus intermedia
Eucalyptus latifolia
Eucalyptus maculata
Eucalyptus microtheca
Eucalyptus miniata
Eucalyptus orgadophila
Eucalyptus papuana
Eucalyptus polysciada
Eucalyptus setosa
Eucalyptus socialis
Eucalyptus tectifica
Eucalyptus tereticornis
Eucalyptus terminalis
Eucalyptus tessellaris
Eucalyptus trachyphloia
Zygophyllaceae
Nitraria billardierei

Amyema biniflora **19 6**

Myrtaceae
Eucalyptus crebra
Eucalyptus dichromophloia
Eucalyptus polysciada
Eucalyptus setosa
Eucalyptus terminalis
Eucalyptus thozetiana

Amyema cambagei **258 10**
Casuarinaceae
Allocasuarina littoralis
Allocasuarina luehmannii
Allocasuarina torulosa
Casuarina cristata
Casuarina cunninghamiana
Casuarina glauca
Cupressaceae
Callitris glaucophylla
Mimosaceae
Acacia parramattensis
Myoporaceae
Eremophila mitchellii
Myrtaceae
Eucalyptus sp.
Melaleuca styphelioides

Amyema congener **340 90**
Apocynaceae
Nerium oleander *
Parsonsia straminea
Araliaceae
Astrotricha floccosa
Caesalpiniaceae
Senna odorata
Capparaceae
Capparis arborea
Casuarinaceae
Allocasuarina littoralis
Allocasuarina thalassoscopica
Allocasuarina torulosa
Casuarina cristata
Casuarina cunninghamiana
Casuarina glauca
Celastraceae
Cassine australis
Cassine melanocarpa
Elaeodendron sp.
Combretaceae
Lumnitzera littorea
Lumnitzera racemosa
Terminalia muellerii
Erythroxylaceae
Erythroxylum australe
Euphorbiaceae
Croton arnhemicus
Croton insularis
Croton phebalioides
Croton verreauxii
Excoecaria agallocha
Mallotus philippinensis
Petalostigma pubescens
Fabaceae
Pongamia pinnata *
Fagaceae
Quercus bicolor
Illiciaceae
Illicium religiosum
Loranthaceae
Amyema cambagei
Amyema miquelii
Amyema pendula
Dendrophthoe curvata
Dendrophthoe falcata
Muellerina celastroides
Muellerina eucalyptoides
Lythraceaeraceae
Lagerstroemia indica *
Meliaceae
Melia azedarach
Mimosaceae
Acacia anceps
Acacia concurrens
Acacia decurrens
Acacia diphylla
Acacia fasciculifera
Acacia fimbriata
Acacia floribunda
Acacia maidenii
Acacia mearnsii
Acacia melanoxylon
Acacia penninervis
Acacia podalyriifolia
Acacia polybotrya
Myoporaceae
Eremophila mitchellii
Myrtaceae
Acmena smithii
Backhousia sciadophora
Callistemon viminalis
Eucalyptus acmenoides
Eucalyptus bancroftii
Eucalyptus maculata
Eucalyptus obstans
Eucalyptus tereticornis
Leptospermum brachyandrum
Leptospermum polygalifolium
Lophostemon confertus
Melaleuca decora
Melaleuca linariifolia
Melaleuca nodosa
Melaleuca parviflora
Melaleuca styphelioides
Oleaceae
Notelaea microcarpa
Proteaceae
Banksia integrifolia
Rhamnaceae
Alphitonia excelsa
Rhizophoraceae
Ceriops tagal
Rosaceae
Crataegus spathulata *
Prunus persica *
Pyrus communis *
Rubiaceae
Canthium oleifolium
Randia fitzalanii
Rutaceae
Acronychia laevis
Acradmia euodiiformis

Rutaceae cont.
Citrus aurantium *
Citrus limon *
Citrus sinensis *
Flindersia maculosa
Geijera parviflora
Geijera salicifolia
Salicaceae
Salix babylonica *
Santalaceae
Exocarpos cupressiformis
Santalum lanceolatum
Sapindaceae
Cupaniopsis anacardioides
Cupaniopsis serrata
Sapotaceae
Planchonella sp.
Pouteria sericea
Thymelaeaceae
Pimelea sp.
Ulmaceae
Celtis acuminata *

Amyema conspicua **125 20**

Apocynaceae
Alyxia spicata
Caesalpiniaceae
Bauhinia sp.
Lysiphyllum cunninghamii
Capparaceae
Capparis sp.
Casuarinaceae
Allocasuarina littoralis
Casuarina sp.
Combretaceae
Terminalia sp.
Erythroxylaceae
Erythroxylum australe
Erythroxylum ellipticum
Euphorbiaceae
Croton tomentellus
Excoecaria agallocha
Petalostigma quadriloculare
Lythraceaeraceae
Pemphis acidula
Malvaceae
Thespesia populnea
Meliaceae
Turraea virens
Xylocarpus granatum
Xylocarpus moluccensis
Mimosaceae
Acacia crassicarpa
Myrtaceae
Callistemon sp.
Melaleuca sp.
Psidium guajava *
Proteaceae
Grevillea sp.
Rhamnaceae
Alphitonia excelsa
Alphitonia petriei
Alphitonia whitei
Rubiaceae
Gardenia sp.
Rutaceae
Citrus sinensis *
Sapindaceae
Alectryon connatus
Sapotaceae
Pouteria sp.
Urticaceae
Boehmeria sp.

Amyema dolichopoda **13 3**

Combretaceae
Lumnitzera racemosa
Meliaceae
Owenia reticulata
Mimosaceae
Acacia victoriae

Amyema eburna **12 2**

Myrtaceae
Eucalyptus dichromophloia
Eucalyptus papuana

Amyema fitzgeraldii **98 7**

Mimosaceae
Acacia acuminata
Acacia aneura
Acacia linophylla
Acacia quadrimarginea
Acacia ramulosa
Acacia rostellifera
Acacia tetragonophylla

Amyema friesiana **4 0**

No recorded host species

Amyema gaudichaudii **63 7**

Mimosaceae
Acacia sp.
Myrtaceae
Callistemon linearis
Melaleuca decora
Melaleuca lanceolata
Melaleuca linariifolia
Melaleuca nodosa
Melaleuca parviflora
Melaleuca styphelioides

Amyema gibberula **226 20**

Casuarinaceae
Casuarina cristata
Mimosaceae
Acacia acuminata
Acacia aneura
Acacia linophylla
Acacia ramulosa

Myrtaceae
Eucalyptus deserticola
Eucalyptus terminalis
Proteaceae
Grevillea agrifolia
Grevillea juncifolia
Grevillea nematophylla
Grevillea pyramidalis
Grevillea stenobotrya
Grevillea striata
Grevillea wickhamii
Hakea chordophylla
Hakea divaricata
Hakea leucoptera
Hakea lorea
Hakea recurva
Hakea suberea

Amyema glabra **16** **3**
Myrtaceae
Callistemon sp.
Rhamnaceae
Alphitonia sp.
Rutaceae
Citrus sp. *
Sapindaceae
Guioa acutifolia
Sterculiaceae
Commersonia bartramia
Urticaceae
Pipturus argenteus

Amyema haematodes **15** **3**
Euphorbiaceae
Mallotus nesophilus
Lecythidaceae
Barringtonia acutangula
Moraceae
Ficus scobina
Sapotaceae
Pouteria sp.

Amyema herbertiana **16** **2**
Myrtaceae
Melaleuca alsophila
Melaleuca foliolosa

Amyema hilliana **52** **6**
Caesalpiniaceae
Cassia sp.
Mimosaceae
Acacia aneura
Acacia citrinoviridis
Acacia estrophiolata
Acacia pruinocarpa
Acacia pruinosa
Acacia victoriae

Amyema linophylla **167** **8**
Casuarinaceae
Allocasuarina luehmannii
Casuarina cristata
Casuarina glauca
Casuarina obesa
Loranthaceae
Amyema cambagei
Amyema miraculosa
Mimosaceae
Acacia melanoxylon
Myoporaceae
Eremophila mitchellii

Amyema lucasii **68** **7**
Capparaceae
Capparis canescens
Proteaceae
Grevillea striata
Rutaceae
Eremocitrus glauca
Flindersia australis
Flindersia collina
Flindersia maculosa
Geijera parviflora

Amyema mackayense **84** **10**
Bombacaceae
Camptostemon schultzii
Combretaceae
Lumnitzera sp.
Euphorbiaceae
Excoecaria agallocha
Mallotus nesophilus
Malvaceae
Thespesia sp.
Myrsinaceae
Aegiceras corniculatum
Myrtaceae
Melaleuca leucadendra
Rhizophoraceae
Ceriops tagal
Rhizophora mucronata
Rhizophora stylosa
Sapotaceae
Pouteria sericea
Verbenaceae
Avicennia marina

Amyema maidenii **402** **37**
Apocynaceae
Carissa lanceolata
Caesalpiniaceae
Bauhinia carronii
Cassia artemisioides
Erythrophloeum chlorostachys
Casuarinaceae
Casuarina sp.
Loranthaceae
Lysiana exocarpi

Mimosaceae
Acacia adsurgens
Acacia aneura
Acacia brachystachya
Acacia burkittii
Acacia calamifolia
Acacia calcicola
Acacia cambagei
Acacia catenulata
Acacia citrinoviridis
Acacia clivicola
Acacia coriacea
Acacia cyperophylla
Acacia doratoxylon
Acacia estrophiolata
Acacia harpophylla
Acacia holosericea
Acacia homalophylla
Acacia kempeana
Acacia linophylla
Acacia loderi
Acacia murrayana
Acacia oswaldii
Acacia papyrocarpa
Acacia pendula
Acacia ramulosa
Acacia shirleyi
Acacia stenophylla
Acacia stowardii
Acacia tetragonophylla
Acacia victoriae
Myoporaceae
Myoporum platycarpum
Myrtaceae
Eucalyptus pachyphylla
Proteaceae
Grevillea sp.
Sapindaceae
Atalaya sp.

Amyema melaleucae **138** **8**

Casuarinaceae
Casuarina sp.
Myoporaceae
Myoporum sp.
Myrtaceae
Melaleuca cardiophylla
Melaleuca halmaturorum
Melaleuca lanceolata
Melaleuca parviflora
Melaleuca pauperiflora
Melaleuca pubescens
Melaleuca quadrifaria
Melaleuca thyoides
Pittosporaceae
Pittosporum sp.
Santalaceae
Exocarpos sp.

Amyema microphylla **15** **3**

Myrtaceae
Melaleuca leiocarpa
Melaleuca pauperiflora
Melaleuca uncinata

Amyema miquelii **919** **125**

Casuarinaceae
Allocasuarina verticillata
Casuarina sp.
Cupressaceae
Callitris endlicheri
Euphorbiaceae
Petalostigma pubescens
Lecythidaceae
Planchonia careya
Loranthaceae
Amyema cambagei
Amyema miquelii
Muellerina eucalyptoides
Mimosaceae
Acacia aneura
Acacia dealbata
Acacia farnesiana
Acacia mearnsii
Acacia victoriae
Myrtaceae
Angophora floribunda
Eucalyptus albens
Eucalyptus aspera
Eucalyptus baueriana
Eucalyptus bicostata
Eucalyptus bigalerita
Eucalyptus blakelyi
Eucalyptus bleeseri
Eucalyptus botryoides
Eucalyptus brachycalyx
Eucalyptus bridgesiana
Eucalyptus caleyi
Eucalyptus calophylla
Eucalyptus camaldulensis
Eucalyptus cambageana
Eucalyptus cinerea
Eucalyptus cladocalyx
Eucalyptus concinna
Eucalyptus conica
Eucalyptus coolabah
Eucalyptus crebra
Eucalyptus dalrympleana
Eucalyptus dealbata
Eucalyptus dichromophloia
Eucalyptus drepanophylla
Eucalyptus drummondii
Eucalyptus dumosa
Eucalyptus dwyeri
Eucalyptus eremicola
Eucalyptus eugenioides
Eucalyptus ewartiana
Eucalyptus exserta
Eucalyptus fasciculosa
Eucalyptus fibrosa

Myrtaceae cont.
Eucalyptus flocktoniae
Eucalyptus gamophylla
Eucalyptus gillenii
Eucalyptus gillii
Eucalyptus glaucescens
Eucalyptus gomphocephala
Eucalyptus gongylocarpa
Eucalyptus goniocalyx
Eucalyptus gracilis
Eucalyptus gummifera
Eucalyptus intertexta
Eucalyptus kingsmillii
Eucalyptus kondininensis
Eucalyptus laeliae
Eucalyptus largiflorens
Eucalyptus leptophylla
Eucalyptus leucophloia
Eucalyptus leucoxylon
Eucalyptus longifolia
Eucalyptus loxophleba
Eucalyptus macrorrhyncha
Eucalyptus maculata
Eucalyptus mannifera
Eucalyptus melanophloia
Eucalyptus melliodora
Eucalyptus microcarpa
Eucalyptus microcorys
Eucalyptus microtheca
Eucalyptus miniata
Eucalyptus moluccana
Eucalyptus nortonii
Eucalyptus odontocarpa
Eucalyptus odorata
Eucalyptus oldfieldii
Eucalyptus oleosa
Eucalyptus optima
Eucalyptus oxymitra
Eucalyptus pachyphylla
Eucalyptus papuana
Eucalyptus patens
Eucalyptus pileata
Eucalyptus pilularis
Eucalyptus pimpiniana
Eucalyptus platyphylla
Eucalyptus polyanthemos
Eucalyptus populnea
Eucalyptus porosa
Eucalyptus prava
Eucalyptus pruinosa
Eucalyptus punctata
Eucalyptus pyriformis
Eucalyptus racemosa
Eucalyptus resinifera
Eucalyptus rossii
Eucalyptus rubida
Eucalyptus rudis
Eucalyptus saligna
Eucalyptus salmonophloia
Eucalyptus scoparia
Eucalyptus sessilis
Eucalyptus siderophloia
Eucalyptus sideroxylon
Eucalyptus socialis
Eucalyptus sparsifolia
Eucalyptus spathulata
Eucalyptus tectifica
Eucalyptus tereticornis
Eucalyptus tessellaris
Eucalyptus tetrodonta
Eucalyptus todtiana
Eucalyptus transcontinentalis
Eucalyptus umbra
Eucalyptus viminalis
Eucalyptus viridis
Eucalyptus wandoo
Eucalyptus youngiana
Eucalyptus yumbarrana
Melaleuca cardiophylla
Rubiaceae
Canthium sp.
Santalaceae
Exocarpos cupressiformis
Sterculiaceae
Brachychiton sp.

Amyema miraculosa **351** **41**

Casuarinaceae
Allocasuarina luehmannii
Allocasuarina verticillata
Casuarina sp.
Cupressaceae
Callitris glaucophylla
Loranthaceae
Amyema cambagei
Amyema linophylla
Amyema miquelii
Amyema pendula
Mimosaceae
Acacia aneura
Acacia cambagei
Acacia colletioides
Acacia doratoxylon
Acacia excelsa
Acacia harpophylla
Acacia homalophylla
Acacia pendula
Acacia rostellifera
Acacia salicina
Myoporaceae
Eremophila bignoniiflora
Eremophila duttonii
Eremophila freelingii
Eremophila longifolia
Eremophila mitchellii
Eremophila sturtii
Myoporum acuminatum
Myoporum platycarpum
Myrtaceae
Eucalyptus camaldulensis
Eucalyptus largiflorens
Eucalyptus melliodora

Myrtaceae cont.
Eucalyptus oleosa
Melaleuca halmaturorum
Melaleuca lanceolata
Syncarpia glomulifera
Pittosporaceae
Pittosporum phylliraeoides
Rhamnaceae
Ventilago viminalis
Rubiaceae
Canthium sp.
Rutaceae
Geijera linearifolia
Geijera parviflora
Santalaceae
Exocarpos aphyllus
Santalum acuminatum
Santalum lanceolatum
Santalum spicatum
Sapindaceae
Alectryon oleifolius
Solanaceae
Anthocercis sp.

Amyema nestor **40** **5**

Mimosaceae
Acacia acuminata
Acacia aneura
Acacia burkittii
Acacia quadrimarginea
Acacia tetragonophylla
Myoporaceae
Eremophila sp.

Amyema pendula **399** **75**

Casuarinaceae
Allocasuarina torulosa
Allocasuarina verticillata
Casuarina sp.
Celastraceae
Siphonodon australis
Loranthaceae
Amyema cambagei
Amyema gaudichaudii
Muellerina eucalyptoides
Mimosaceae
Acacia baileyana
Acacia dealbata
Acacia decurrens
Acacia fimbriata
Acacia irrorata
Acacia linifolia
Acacia mearnsii
Acacia melanoxylon
Acacia obliquinervia
Acacia paradoxa
Acacia parramattensis
Acacia pycnantha
Acacia retinervis
Acacia silvestris
Myrtaceae
Angophora floribunda
Eucalyptus agglomerata
Eucalyptus albens
Eucalyptus amplifolia
Eucalyptus andrewsii
Eucalyptus bancroftii
Eucalyptus baueriana
Eucalyptus baxteri
Eucalyptus blakelyi
Eucalyptus blaxlandii
Eucalyptus bosistoana
Eucalyptus bridgesiana
Eucalyptus camaldulensis
Eucalyptus capitellata
Eucalyptus cephalocarpa
Eucalyptus cinerea
Eucalyptus cosmophylla
Eucalyptus dalrympleana
Eucalyptus delegatensis
Eucalyptus diversifolia
Eucalyptus dives
Eucalyptus eugenioides
Eucalyptus fasciculosa
Eucalyptus goniocalyx
Eucalyptus gummifera
Eucalyptus haemastoma
Eucalyptus laevopinea
Eucalyptus leucoxylon
Eucalyptus macrorrhyncha
Eucalyptus mannifera
Eucalyptus melliodora
Eucalyptus micranthera
Eucalyptus moorei
Eucalyptus muelleriana
Eucalyptus nortonii
Eucalyptus nova-anglica
Eucalyptus obliqua
Eucalyptus ovata
Eucalyptus pilularis
Eucalyptus piperita
Eucalyptus polyanthemos
Eucalyptus propinqua
Eucalyptus racemosa
Eucalyptus radiata
Eucalyptus rossii
Eucalyptus seeana
Eucalyptus siderophloia
Eucalyptus sideroxylon
Eucalyptus sieberi
Eucalyptus sparsifolia
Eucalyptus stellulata
Eucalyptus tereticornis
Eucalyptus viminalis
Eucalyptus willisii
Rosaceae
Crataegus monogyna *

Amyema plicatula **2** **1**

Meliaceae
Dysoxylum fraseranum

Amyema preissii **642** **73**

Caesalpiniaceae
Cassia artemisioides
Cassia nemophila
Cassia phyllodinea
Cassia sturtii
Senna artemisioides
Senna filifolia
Casuarinaceae
Casuarina cristata
Fabaceae
Chamaecytisus palmensis *
Cytisus canariensis *
Templetonia egena
Virgilia capensis
Loranthaceae
Lysiana exocarpi
Mimosaceae
Acacia acuminata
Acacia aneura
Acacia argyrodendron
Acacia baileyana
Acacia bivenosa
Acacia blakelyi
Acacia brachybotrya
Acacia brachystachya
Acacia burkittii
Acacia calamifolia
Acacia calcicola
Acacia cambagei
Acacia colletioides
Acacia cuthbertsonii
Acacia cyclops
Acacia decurrens
Acacia dictyophleba
Acacia dodonaeifolia
Acacia estrophiolata
Acacia hakeoides
Acacia hemiteles
Acacia jennerae
Acacia kempeana
Acacia ligulata
Acacia linophylla
Acacia loderi
Acacia mearnsii
Acacia melanoxylon
Acacia murrayana
Acacia notabilis
Acacia nyssophylla
Acacia oswaldii
Acacia papyrocarpa
Acacia podalyriifolia
Acacia pycnantha
Acacia ramulosa
Acacia retinervis
Acacia rhigiophylla
Acacia rigens
Acacia rivalis
Acacia rostellifera
Acacia salicina
Acacia saligna
Acacia sclerophylla
Acacia shirleyi
Acacia stenophylla
Acacia tarculensis
Acacia tetragonophylla
Acacia trachycarpa
Acacia vestita
Acacia victoriae
Myoporaceae
Eremophila oppositifolia
Myoporum platycarpum
Myrtaceae
Calytrix sp.
Eucalyptus gamophylla
Melaleuca uncinata
Proteaceae
Grevillea wickhamii
Hakea arida
Hakea eyreana
Rutaceae
Geijera parviflora
Santalaceae
Exocarpos aphyllus
Santalum sp.
Sapindaceae
Alectryon oleifolius

Amyema pyriforme **4** **1**

Myrtaceae
Eucalyptus rupestris

Amyema quandang **590** **53**

Apocynaceae
Carissa ovata
Caesalpiniaceae
Bauhinia sp.
Casuarinaceae
Casuarina sp.
Cupressaceae
Callitris sp.
Euphorbiaceae
Mallotus claoxyloides
Meliaceae
Owenia acidula
Mimosaceae
Acacia ammobia
Acacia aneura
Acacia argyrodendron
Acacia baileyana
Acacia blakei
Acacia burkittii
Acacia burrowii
Acacia cambagei
Acacia cana
Acacia cheelii
Acacia colletioides
Acacia crassa
Acacia dealbata
Acacia deanei
Acacia decurrens

Mimosaceae cont.
Acacia doratoxylon
Acacia excelsa
Acacia georginae
Acacia gonoclada
Acacia harpophylla
Acacia homalophylla
Acacia kempeana
Acacia leiocalyx
Acacia loderi
Acacia longispicata
Acacia macdonnelliensis
Acacia mearnsii
Acacia melanoxylon
Acacia neriifolia
Acacia omalophylla
Acacia oswaldii
Acacia papyrocarpa
Acacia pendula
Acacia pycnantha
Acacia rigens
Acacia shirleyi
Acacia silvestris
Acacia sparsiflora
Acacia tetragonophylla
Acacia victoriae
Myoporaceae
Eremophila mitchellii
Myoporum platycarpum
Myrtaceae
Eucalyptus lacrimans
Eucalyptus largiflorens
Melaleuca lanceolata
Proteaceae
Hakea arborescens
Rutaceae
Flindersia maculosa
Geijera parviflora
Sapindaceae
Alectryon diversifolius
Alectryon oleifolius

Amyema quaternifolia **12 0**
No recorded host species

Amyema queenslandica **45 9**
Burseraceae
Canarium australasicum
Canarium muelleri
Elaeocarpaceae
Sloanea macbrydei
Lauraceae
Cryptocarya angulata
Meliaceae
Dysoxylum mollissimum
Moraceae
Ficus crassipes
Myrtaceae
Syncarpia sp.
Pinaceae
Pinus elliottii
Proteaceae
Grevillea sp.
Rhamnaceae
Alphitonia petriei
Rutaceae
Acronychia vestita

Amyema sanguinea **325 34**
Mimosaceae
Acacia sp.
Myrtaceae
Eucalyptus apodophylla
Eucalyptus aspera
Eucalyptus brachyandra
Eucalyptus camaldulensis
Eucalyptus chippendalei
Eucalyptus citriodora
Eucalyptus clarksoniana
Eucalyptus confertiflora
Eucalyptus coolabah
Eucalyptus cyanoclada
Eucalyptus deserticola
Eucalyptus dichromophloia
Eucalyptus foelscheana
Eucalyptus grandifolia
Eucalyptus gummifera
Eucalyptus latifolia
Eucalyptus leptophleba
Eucalyptus leucophloia
Eucalyptus microtheca
Eucalyptus miniata
Eucalyptus normantonensis
Eucalyptus pachyphylla
Eucalyptus papuana
Eucalyptus phoenicea
Eucalyptus polycarpa
Eucalyptus polysciada
Eucalyptus pruinosa
Eucalyptus setosa
Eucalyptus tectifica
Eucalyptus terminalis
Eucalyptus tessellaris
Eucalyptus tetrodonta
Eucalyptus zygophylla
Leptospermum sp.
Melaleuca sp.
Rubiaceae
Timonius timon

Amyema seemeniana **6 0**
No recorded host species

Amyema subcapitata **1 0**
No recorded host species

Amyema thalassia **29 3**
Bombacaceae
Camptostemon schultzii

Euphorbiaceae
Excoecaria agallocha
Verbenaceae
Avicennia marina

Amyema tridactyla **18** **6**

Myrtaceae
Asteromyrtus magnifica
Baeckea sp.
Calytrix brachychaeta
Calytrix brownii
Calytrix exstipulata
Melaleuca punicea
Regelia punicea

Amyema villiflora **213** **34**

Apocynaceae
Carissa ovata
Wrightia saligna
Caesalpiniaceae
Lysiphyllum cunninghamii
Lysiphyllum hookeri
Casuarinaceae
Casuarina sp.
Combretaceae
Lumnitzera racemosa
Terminalia arostrata
Terminalia bursarina
Terminalia canescens
Terminalia carpentariae
Terminalia ferdinandiana
Terminalia grandiflora
Terminalia melanocarpa
Terminalia platyphylla
Terminalia subacroptera
Erythroxylaceae
Erythroxylum sp.
Euphorbiaceae
Croton habrophyllus
Drypetes lasiogyna
Petalostigma pubescens
Petalostigma quadriloculare
Lecythidaceae
Barringtonia sp.
Loranthaceae
Dendrophthoe glabrescens
Malvaceae
Thespesia populnea
Mimosaceae
Acacia aneura
Acacia doratoxylon
Acacia holosericea
Acacia shirleyi
Moraceae
Ficus virens
Myrtaceae
Eucalyptus polycarpa
Rubiaceae
Aidia racemosa
Gardenia sp.
Rutaceae
Flindersia acuminata
Santalaceae
Exocarpos latifolius
Sapindaceae
Alectryon connatus
Sapotaceae
Planchonella euphlebia
Pouteria sericea
Pouteria unmackiana
Verbenaceae
Premna serratifolia

Amyema whitei **39** **4**

Euphorbiaceae
Macaranga subdentata
Idiospermaceae
Idiospermum australiense
Proteaceae
Musgravea sp.
Rutaceae
Acronychia vestita
Sapindaceae
Synima cordieri
Sapotaceae
Planchonella sp.

Amylotheca dictyophleba **237** **49**

Annonaceae
Polyalthia nitidissima
Bignoniaceae
Jacaranda mimosifolia *
Casuarinaceae
Casuarina cunninghamiana
Clusiaceae
Garcinia sp.
Connaraceae
Connarus conchocarpus
Ebenaceae
Diospyros australis
Elaeagnaceae
Elaeocarpus obovatus
Elaeocarpus reticulatus
Epacridaceae
Leucopogon sp.
Euphorbiaceae
Drypetes lasiogyna
Macaranga subdentata
Mallotus philippinensis
Mallotus polyadenos
Eupomatiaceae
Eupomatia laurina
Flacourticaceae
Scolopia braunii
Grossulariaceae
Abrophyllum ornans
Polyosma cunninghamii
Lauraceae
Beilschmiedia obtusifolia
Cinnamomum camphora

Lauraceae cont.
Cryptocarya cunninghamii
Cryptocarya rigida
Endiandra cowleyana
Endiandra discolor
Endiandra glauca
Endiandra muelleri
Endiandra virens
Meliaceae
Anthocarapa nitidula
Dysoxylum rufum
Mimosaceae
Acacia crassicarpa
Acacia excelsa
Acacia melanoxylon
Monimiaceae
Doryphora aromatica
Doryphora sassafras
Moraceae
Ficus opposita
Pseudomorus brunoniana
Myrsinaceae
Rapanea variabilis
Myrtaceae
Acmena smithii
Austromyrtus sp.
Backhousia sciadophora
Eugenia sp.
Lophostemon suaveolens
Rhodamnia acuminata
Rhodomyrtus trineura
Syzygium sp.
Rhamnaceae
Alphitonia excelsa
Alphitonia petriei
Rubiaceae
Psychotria sp.
Rutaceae
Acronychia imperforata
Santalaceae
Exocarpos latifolius
Sapindaceae
Cupaniopsis anacardioides
Jagera pseudorhus
Sapotaceae
Chrysophyllum lanceolatum
Planchonella chartacea
Ulmaceae
Aphananthe philippinensis
Urticaceae
Pipturus argenteus
Verbenaceae
Petrea sp.

Amylotheca subumbellata **12** **6**

Casuarinaceae
Casuarina sp.
Myrtaceae
Archirhodomyrtus beckleri
Eucalyptus sideroxylon
Rhodomyrtus sericea
Rhodomyrtus trineura
Pittosporaceae
Pittosporum venulosum
Proteaceae
Grevillea pteridifolia

Benthamina alyxifolia **41** **10**

Boraginaceae
Ehretia acuminata
Casuarinaceae
Allocasuarina littoralis
Allocasuarina verticillata
Casuarina sp.
Mimosaceae
Acacia melanoxylon
Monimiaceae
Daphnandra micrantha
Myrtaceae
Callistemon viminalis
Eugenia sp.
Proteaceae
Macadamia sp.
Sapindaceae
Cupaniopsis anacardioides
Guioa semiglauca
Solanaceae
Duboisia myoporoides
Ulmaceae
Aphananthe philippinensis

Cecarria obtusifolia **8** **1**

Myrtaceae
Xanthostemon chrysanthus

Dactyliophora novaeguineae **10** **0**

Euphorbiaceae
Mallotus sp.

Decaisnina angustata **83** **18**

Anacaridaceae
Buchanania obovata
Caesalpiniaceae
Erythrophloeum chlorostachys
Celastraceae
Denhamia obscura
Chrysobalanaceae
Maranthes corymbosa
Combretaceae
Terminalia sp.
Fabaceae
Derris uliginosa
Lecythidaceae
Barringtonia acutangula
Planchonia careya
Meliaceae
Owenia sp.
Moraceae
Ficus leucotricha
Ficus opposita

Moraceae cont.		
Ficus platypoda		
Ficus scobina		
Ficus virens		
Myrtaceae		
Eucalyptus confertiflora		
Lophostemon grandiflorus		
Melaleuca sp.		
Syzygium suborbiculare		
Tristania sp.		
Proteaceae		
Banksia dentata		
Rubiaceae		
Timonius timon		
Sapotaceae		
Pouteria sericea		
Decaisnina biangulata	**13**	**2**
Combretaceae		
Terminalia sp.		
Myrtaceae		
Lophostemon grandiflorus		
Syzygium eucalyptoides		
Tristania sp.		
Decaisnina brittenii	**126**	**20**
Anacardiaceae		
Buchanania obovata		
Euroschinus falcata		
Apocynaceae		
Alstonia actinophylla		
Chrysobalanaceae		
Parinari nonda		
Combretaceae		
Terminalia sp.		
Lecythidaceae		
Barringtonia acutangala		
Barringtonia asiatica		
Planchonia careya		
Moraceae		
Ficus benjamina		
Myrtaceae		
Eucalyptus sp.		
Lophostemon grandiflorus		
Lophostemon lactifluus		
Lophostemon suaveolens		
Melaleuca acacioides		
Melaleuca argentea		
Melaleuca cajuputi		
Melaleuca dealbata		
Melaleuca leucadendra		
Melaleuca saligna		
Melaleuca viridiflora		
Syzygium eucalyptoides		
Syzygium suborbiculare		
Tristania sp.		
Rhamnaceae		
Alphitonia sp.		
Decaisnina congesta	**15**	**2**
Apocynaceae		
Alstonia muelleriana		
Moraceae		
Morus nigra		
Decaisnina hollrungii	**13**	**1**
Lecythidaceae		
Planchonia careya		
Decaisnina signata	**136**	**28**
Anacaridaceae		
Buchanania obovata		
Apocynaceae		
Alstonia actinophylla		
Nerium oleander *		
Asclepiadaceae		
Asclepias sp.		
Chrysobalanaceae		
Parinari nonda		
Combretaceae		
Terminalia sp.		
Euphorbiaceae		
Antidesma ghaesembilla		
Excoecaria agallocha		
Mallotus polyadenos		
Petalostigma sp.		
Lecythidaceae		
Barringtonia acutangula		
Planchonia careya		
Loranthaceae		
Amyema bifurcata		
Mimosaceae		
Mimosa pigra *		
Moraceae		
Ficus opposita		
Ficus platypoda		
Ficus scobina		
Ficus virens		
Morus nigra		
Myrtaceae		
Eucalyptus tetrodonta		
Eugenia sp.		
Lophostemon lactifluus		
Melaleuca cajuputi		
Melaleuca dealbata		
Melaleuca viridiflora		
Syzygium eucalyptoides		
Syzygium suborbiculare		
Tristania sp.		
Xanthostemon eucalyptoides		
Proteaceae		
Banksia dentata		
Rubiaceae		
Coelospermum reticulatum		
Ixora timorensis		
Timonius timon		

Decaisnina triflora **63** **25**

Anacardiaceae
Buchanania arborescens
Buchanania obovata
Semecarpus australiensis
Apocynaceae
Ervatamia orientalis
Asclepiadaceae
Asclepias sp.
Casuarinaceae
Casuarina equisetifolia
Chrysobalanaceae
Maranthes corymbosa
Clusiaceae
Calophyllum soulattri
Combretaceae
Terminalia sp.
Dilleniaceae
Dillena alata
Ebenaceae
Diospyros littorea
Elaeagnaceae
Elaeocarpus arnhemicus
Euphorbiaceae
Glochidion sp.
Lauraceae
Cryptocarya cunninghamii
Litsea ferruginea
Lecythidaceae
Planchonia careya
Mimosaceae
Acacia pellita
Moraceae
Ficus scobina
Myristicaceae
Myristica insipida
Myrtaceae
Lophostemon lactifluus
Syzygium fibrosum
Rhamnaceae
Alphitonia excelsa
Rhizophoraceae
Carallia brachiata
Rubiaceae
Ixora timorensis
Psydrax lamprophylla
Timonius timon
Sapotaceae
Pouteria sericea
Thymelaeaceae
Wikstroemia indica

Dendrophthoe acacioides **175** **30**

Anacaridaceae
Blepharocarya depauperata
Bixaceae
Cochlospermum fraseri
Bombacaceae
Adansonia gregorii
Caesalpiniaceae
Erythrophloeum chlorostachys
Capparaceae
Capparis mitchellii
Combretaceae
Terminalia canescens
Terminalia ferdinandiana
Terminalia fitzgeraldii
Terminalia platyphylla
Mimosaceae
Acacia aulacocarpa
Acacia delibrata
Acacia dimidiata
Acacia dunnii
Acacia holosericea
Acacia monticola
Acacia mountfordiae
Acacia pellita
Acacia plectocarpa
Acacia retinervis
Acacia sericata
Acacia tumida
Myrtaceae
Eucalyptus miniata
Melaleuca sp.
Metrosideros sp.
Syzygium suborbiculare
Proteaceae
Grevillea angulata
Grevillea heliosperma
Grevillea parallela
Grevillea pteridifolia
Rhamnaceae
Ventilago sp.
Rubiaceae
Gardenia sp.
Simaroubaceae
Ailanthus triphysa
Sterculiaceae
Brachychiton diversifolius
Sterculia viscidula

Dendrophthoe curvata **93** **29**

Anacardiaceae
Pleiogynium timorense
Annonaceae
Annona muricata
Apocynaceae
Cerbera sp.
Bignoniaceae
Jacaranda mimosifolia *
Caesalpiniaceae
Bauhinia sp.
Casuarinaceae
Casuarina sp.
Euphorbiaceae
Glochidion hylandii
Lauraceae
Cryptocarya triplinervis

Loranthaceae
Muellerina eucalyptoides
Meliaceae
Melia azedarach
Mimosaceae
Acacia aulacocarpa
Archidendron grandiflorum
Moraceae
Ficus sp.
Myrtaceae
Acmena sp.
Angophora floribunda
Callistemon viminalis
Eucalyptus camaldulensis
Eucalyptus cullenii
Eucalyptus gummifera
Eucalyptus papuana
Lophostemon suaveolens
Melaleuca bracteata
Melaleuca nodosa
Melaleuca quinquenervia
Syzygium sp.
Platanaceae
Platanus orientalis *
Proteaceae
Lomatia fraxinifolia
Rhamnaceae
Alphitonia excelsa
Alphitonia petriei
Alphitonia philipensis
Rutaceae
Acronychia vestita
Citrus limon *
Citrus sinensis *
Flindersia acuminata
Verbenaceae
Lantana camara *

Dendrophthoe glabrescens **302** **76**

Anacaridaceae
Schinus areira *
Apocynaceae
Nerium oleander *
Bombacaceae
Adansonia gregorii
Burseraceae
Canarium australasicum
Canarium australianum
Caesalpiniaceae
Erythrophloeum chlorostachys
Casuarinaceae
Allocasuarina inophloia
Allocasuarina littoralis
Casuarina cristata
Chrysobalanaceae
Parinari nonda
Combretaceae
Terminalia aridicola
Ebenaceae
Diospyros ferrea
Euphorbiaceae
Excoecaria agallocha
Flueggia virosa
Mallotus nesophilus
Fabaceae
Chamaecytisus palmensis *
Tephrosia brachyodon
Fagaceae
Quercus robur *
Lecythidaceae
Barringtonia acutangula
Barringtonia asiatica
Loranthaceae
Amyema cambagei
Amyema villiflora
Magnoliaceae
Magnolia grandiflora *
Melastomataceae
Melastoma polyanthum
Mimosaceae
Acacia aulacocarpa
Acacia bidwillii
Acacia concurrens
Acacia crassicarpa
Acacia excelsa
Acacia farnesiana
Acacia mangium
Acacia rothii
Acacia salicina
Moraceae
Ficus platypoda
Myrtaceae
Angophora floribunda
Callistemon viminalis
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus coolabah
Eucalyptus crebra
Eucalyptus dealbata
Eucalyptus decorticans
Eucalyptus exserta
Eucalyptus lamoprophylla
Eucalyptus leptophleba
Eucalyptus melanophloia
Eucalyptus microtheca
Eucalyptus papuana
Eucalyptus platyphylla
Eucalyptus setosa
Eucalyptus tereticornis
Eucalyptus tetrodonta
Eucalyptus trachyphloia
Eucalyptus viridis
Lophostemon grandiflorus
Lophostemon suaveolens
Melaleuca dealbata
Melaleuca leucadendra
Melaleuca quinquenervia
Melaleuca saligna
Melaleuca stenostachya
Melaleuca viridiflora
Neofabricia myrtifolia

Myrtaceae cont.
Tristania sp.
Welchiodendron longivalve
Proteaceae
Grevillea decora
Grevillea sessilis
Rhizophoraceae
Rhizophora stylosa
Rubiaceae
Pavetta australiensis
Sapindaceae
Atalaya hemiglauca
Cupaniopsis anacardioides
Dodonaea platyptera
Sterculiaceae
Brachychiton australis
Brachychiton populneus
Brachychiton rupestris
Commersonia bartramia
Sterculia quadrifida

Dendrophthoe homoplastica **55** **15**

Anacaridaceae
Buchanania obovata
Combretaceae
Terminalia platyphylla
Mimosaceae
Acacia sp.
Myrtaceae
Eucalyptus crebra
Eucalyptus dolichocarpa
Eucalyptus exserta
Eucalyptus melanophloia
Eucalyptus setosa
Eucalyptus shirleyi
Lophostemon confertus
Lophostemon grandiflorus
Lophostemon lactifluus
Lophostemon suaveolens
Melaleuca argentea
Melaleuca leucadendra
Tristania sp.
Proteaceae
Grevillea pteridifolia

Dendrophthoe odontocalyx **125** **24**

Anacaridaceae
Buchanania obovata
Caesalpiniaceae
Erythrophloeum chlorostachys
Combretaceae
Terminalia sp.
Lythraceaeraceae
Lagerstroemia indica *
Mimosaceae
Acacia clavigera
Acacia excelsa
Acacia farnesiana
Acacia latescens

Myrtaceae
Allosyncarpia ternata
Eucalyptus camaldulensis
Eucalyptus foelscheana
Eucalyptus papuana
Eucalyptus phoenicea
Eucalyptus polysciada
Eucalyptus tectifica
Eugenia sp.
Melaleuca argentea
Melaleuca cajuputi
Melaleuca viridiflora
Syzygium suborbiculare
Xanthostemon psidioides
Proteaceae
Grevillea arenaria
Grevillea pteridifolia
Grevillea refracta
Hakea arborescens
Persoonia falcata

Dendrophthoe vitellina **346** **76**

Anacaridaceae
Schinus areira *
Annonaceae
Annona muricata
Apocynaceae
Nerium oleander *
Burseraceae
Canarium australianum
Casuarinaceae
Allocasuarina littoralis
Casuarina cunninghamiana
Clusiaceae
Calophyllum sp.
Euphorbiaceae
Excoecaria agallocha
Fabaceae
Chamaecytisus palmensis *
Lauraceae
Cryptocarya triplinervis
Lecythidaceae
Barringtonia sp.
Loranthaceae
Amyema pendula
Muellerina eucalyptoides
Lythraceaeraceae
Lagerstroemia sp.
Magnoliaceae
Magnolia sp. *
Malvaceae
Hibiscus tiliaceus
Meliaceae
Melia azedarach
Mimosaceae
Acacia aulacocarpa
Acacia decurrens
Acacia linifolia
Acacia paradoxa
Pithecellobium sp.

Myrsinaceae
Rapanea porosa
Myrtaceae
Angophora bakeri
Angophora costata
Angophora floribunda
Angophora subvelutina
Callistemon citrinus
Callistemon linearis
Callistemon rigidus
Callistemon viminalis
Eucalyptus acmenoides
Eucalyptus amplifolia
Eucalyptus calophylla
Eucalyptus camaldulensis
Eucalyptus dolichocarpa
Eucalyptus eximia
Eucalyptus fibrosa
Eucalyptus globoidea
Eucalyptus gummifera
Eucalyptus haemastoma
Eucalyptus intermedia
Eucalyptus leptophleba
Eucalyptus maculata
Eucalyptus notabilis
Eucalyptus obstans
Eucalyptus piperita
Eucalyptus punctata
Eucalyptus seeana
Eucalyptus shirleyi
Eucalyptus tereticornis
Eucalyptus tindalei
Eucalyptus trachyphloia
Eucalyptus umbra
Eugenia sp.
Kunzea ambigua
Kunzea capitata
Leptospermum sp.
Lophostemon confertus
Lophostemon laurina
Lophostemon suaveolens
Melaleuca leucadendra
Melaleuca linariifolia
Melaleuca nodosa
Melaleuca parviflora
Melaleuca quinquenervia
Melaleuca styphelioides
Psidium guajava
Tristania neriifolia
Pinaceae
Pinus sp. *
Pittosporaceae
Bursaria spinosa
Proteaceae
Grevillea robusta
Hakea dactyloides
Persoonia linearis
Rosaceae
Crataegus monogyna *
Cydonia oblonga *
Malus domestica *
Pyrus communis *
Rutaceae
Citrus limon *
Euodia sp.
Salicaceae
Populus alba *
Salix babylonica *
Santalaceae
Exocarpos cupressiformis
Sapindaceae
Mischocarpus sp.
Sterculiaceae
Brachychiton populneus
Symplocaceae
Symplocos sp.
Winteraceae
Zygogynum semecarpoides

Diplatia furcata **56** **16**

Loranthaceae
Dendrophthoe vitellina
Myrtaceae
Asteromyrtus angustifolia
Asteromyrtus symphyocarpa
Baeckea sp.
Callistemon viminalis
Eucalyptus sp.
Leptospermum neglectum
Melaleuca bracteata
Melaleuca cajuputi
Melaleuca leucadendra
Melaleuca linariifolia
Melaleuca quinquenervia
Melaleuca viridiflora
Neofabricia myrtifolia
Thryptomene oligandra
Rubiaceae
Canthium vaccinifolium
Rutaceae
Flindersia collina
Sapindaceae
Alectryon diversifolius

Diplatia grandibractea **152** **15**

Loranthaceae
Amyema sanguinea
Myrtaceae
Eucalyptus brownii
Eucalyptus camaldulensis
Eucalyptus coolabah
Eucalyptus crebra
Eucalyptus leucophloia
Eucalyptus melanophloia
Eucalyptus microtheca
Eucalyptus miniata
Eucalyptus normantonensis
Eucalyptus persistens
Eucalyptus populnea
Eucalyptus pruinosa
Eucalyptus tectifica
Melaleuca sp.

Sapindaceae
Atalaya hemiglauca

Diplatia tomentosa **9 4**

Myrtaceae
Melaleuca arcana
Melaleuca leucadendra
Melaleuca nervosa
Melaleuca quinquenervia

Lysiana casuarinae **103 17**

Apocynaceae
Alyxia buxifolia
Caesalpiniaceae
Cassia sp.
Casuarinaceae
Allocasuarina huegeliana
Casuarina glauca
Casuarina obesa
Mimosaceae
Acacia acuminata
Acacia aneura
Acacia craspedocarpa
Acacia kempeana
Acacia pyrifolia
Acacia tetragonophylla
Acacia victoriae
Acacia xiphophylla
Myoporaceae
Eremophila pterocarpa
Myrtaceae
Melaleuca sp.
Pittosporaceae
Pittosporum phylliraeoides
Proteaceae
Hakea preissii
Santalaceae
Exocarpos aphyllus
Santalum lanceolatum
Sapindaceae
Alectryon sp.

Lysiana exocarpi **901 109**

Apocynaceae
Alyxia buxifolia
Nerium oleander *
Caesalpiniaceae
Bauhinia carronii
Bauhinia cunninghamii
Cassia artemisioides
Cassia leurssenii
Cassia nemophila
Cassia sturtii
Lysiphyllum carronii
Lysiphyllum gilvum
Senna artemisioides
Senna filifolia
Capparaceae
Apophyllum anomalum
Capparis lucida
Capparis mitchellii
Casuarinaceae
Allocasuarina luehmannii
Allocasuarina paludosa
Allocasuarina verticillata
Casuarina cristata
Casuarina cunninghamiana
Casuarina glauca
Chenopodiaceae
Chenopodium nitrariaceum
Fabaceae
Chamaecytisus palmensis *
Templetonia egena
Fagaceae
Quercus wislizenii *
Loranthaceae
Amyema maidenii
Amyema miquelii
Amyema quandang
Malvaceae
Lagunaria patersonii
Meliaceae
Owenia acidula
Mimosaceae
Acacia aneura
Acacia argyrodendron
Acacia brachystachya
Acacia burkittii
Acacia calamifolia
Acacia calcicola
Acacia cambagei
Acacia colletioides
Acacia deanei
Acacia dodonaeifolia
Acacia excelsa
Acacia farnesiana
Acacia homalophylla
Acacia kempeana
Acacia ligulata
Acacia longispicata
Acacia mearnsii
Acacia melanoxylon
Acacia oswaldii
Acacia papyrocarpa
Acacia paradoxa
Acacia peuce
Acacia podalyriifolia
Acacia ramulosa
Acacia retinervis
Acacia rivalis
Acacia salicina
Acacia sessiliceps
Acacia stenophylla
Acacia tetragonophylla
Acacia victoriae
Prosopis juliflora
Moraceae
Ficus platypoda
Maclura sp.
Myoporaceae
Eremophila dalyana

Myoporaceae cont.
Eremophila denticulata
Eremophila duttonii
Eremophila freelingii
Eremophila latrobei
Eremophila longifolia
Eremophila maculata
Eremophila mitchellii
Eremophila paisleyi
Eremophila scoparia
Eremophila sturtii
Myoporum platycarpum
Myrtaceae
Eucalyptus coolabah
Eucalyptus fasciculosa
Eucalyptus intertexta
Eucalyptus leucoxylon
Eucalyptus socialis
Eucalyptus viminalis
Melaleuca glomerata
Melaleuca linariifolia
Melaleuca linophylla
Melaleuca pubescens
Melaleuca uncinata
Oleaceae
Jasminum sp. *
Olea europaea *
Pittosporaceae
Bursaria spinosa
Pittosporum phylliraeoides
Polygonaceae
Muehlenbeckia cunninghamii
Proteaceae
Grevillea huegeli
Hakea divaricata
Hakea leucoptera
Rhamnaceae
Ceanothus sp.
Rutaceae
Citrus limon *
Citrus reticulata *
Eremocitrus glauca
Geijera linearifolia
Geijera parviflora
Santalaceae
Exocarpos aphyllus
Exocarpos cupressiformis
Santalum acuminatum
Santalum lanceolatum
Santalum murrayanum
Sapindaceae
Alectryon diversifolius
Alectryon oleifolius
Atalaya hemiglauca
Dodonaea viscosa
Solanaceae
Nicotiana glauca
Zygophyllaceae
Nitraria billardierei

Lysiana filifolia **12** **3**

Casuarinaceae
Allocasuarina luehmannii
Casuarina cunninghamiana
Mimosaceae
Acacia bidwillii

Lysiana linearifolia **74** **16**

Apocynaceae
Nerium oleander *
Caesalpiniaceae
Bauhinia carronii
Cassia phyllodinea
Capparaceae
Apophyllum anomalum
Capparis sp.
Loranthaceae
Amyema quandang
Mimosaceae
Acacia aneura
Acacia burkittii
Acacia colletioides
Acacia excelsa
Acacia farnesiana
Myoporaceae
Eremophila mitchellii
Myrtaceae
Eucalyptus coolabah
Pittosporaceae
Pittosporum phylliraeoides
Proteaceae
Grevillea striata
Rutaceae
Flindersia maculosa
Santalaceae
Santalum lanceolatum

Lysiana maritima **27** **8**

Capparaceae
Capparis sp.
Casuarinaceae
Casuarina glauca
Euphorbiaceae
Excoecaria agallocha
Excoecaria ovalis
Excoecaria parvifolia
Mimosaceae
Acacia leptocarpa
Myoporaceae
Myoporum acuminatum
Rhizophoraceae
Ceriops tagal
Rhizophora mucronata
Verbenaceae
Premna sp.

Lysiana murrayi **249** **18**

Caesalpiniaceae
Cassia desolata

Casuarinaceae
Casuarina sp.
Malvaceae
Gossypium australe
Mimosaceae
Acacia adsurgens
Acacia aneura
Acacia brachystachya
Acacia burkittii
Acacia coriacea
Acacia craspedocarpa
Acacia cyperophylla
Acacia farnesiana
Acacia kempeana
Acacia ramulosa
Acacia tetragonophylla
Acacia victoriae
Myoporaceae
Eremophila freelingii
Eremophila mitchellii
Myrtaceae
Eucalyptus sp.
Melaleuca sp.
Pittosporaceae
Pittosporum phylliraeoides
Polygonaceae
Muehlenbeckia cunninghamii

Lysiana spathulata **432** **82**

Anacaridaceae
Buchanania sp.
Pleiogynium timorense
Apocynaceae
Nerium oleander *
Bombacaceae
Adansonia gregorii
Caesalpiniaceae
Bauhinia sp.
Cassia sturtii
Erythrophloeum chlorostachys
Lysiphyllum cunninghamii
Lysiphyllum hookeri
Senna artemisioides
Capparaceae
Capparis loranthifolia
Capparis umbonata
Combretaceae
Lumnitzera racemosa
Terminalia sp.
Cupressaceae
Callitris columellaris
Callitris glaucophylla
Callitris intratropica
Euphorbiaceae
Excoecaria parvifolia
Flueggia virosa
Loranthaceae
Amyema benthamii
Dendrophthoe odontocalyx
Malvaceae
Lagunaria patersonii
Meliaceae
Owenia sp.
Mimosaceae
Acacia acradenia
Acacia ammobia
Acacia aneura
Acacia aulacocarpa
Acacia bidwillii
Acacia cambagei
Acacia chisholmii
Acacia colei
Acacia coriacea
Acacia cowleana
Acacia dictyophleba
Acacia difficilis
Acacia dolichophylla
Acacia eriopoda
Acacia estrophiolata
Acacia farnesiana
Acacia gonoclada
Acacia hammondii
Acacia hemignosta
Acacia hemsleyi
Acacia holosericea
Acacia julifera
Acacia kempeana
Acacia latifolia
Acacia lysiphloia
Acacia macdonnelliensis
Acacia mangium
Acacia monticola
Acacia orthocarpa
Acacia pendula
Acacia retivenia
Acacia signata
Acacia stipuligera
Acacia tumida
Acacia victoriae
Acacia wickhamii
Moraceae
Ficus obliqua
Ficus platypoda
Myoporaceae
Eremophila sp.
Myrtaceae
Eucalyptus aspera
Eucalyptus camaldulensis
Eucalyptus cliftoniana
Eucalyptus cyanoclada
Eucalyptus leucophloia
Eucalyptus microtheca
Eucalyptus papuana
Melaleuca glomerata
Melaleuca linariifolia
Pittosporaceae
Pittosporum phylliraeoides
Proteaceae
Grevillea pteridifolia
Grevillea striata
Hakea arborescens
Hakea chordophylla

Proteaceae cont.
Hakea macrocarpa
Hakea standleyensis
Persoonia sp.
Rhamnaceae
Alphitonia excelsa
Rubiaceae
Gardenia ochreata
Gardenia resinosa
Rutaceae
Geijera salicifolia
Micromelum minutum
Santalaceae
Santalum lanceolatum
Sapindaceae
Alectryon sp.
Atalaya collina
Atalaya hemiglauca
Dodonaea sp.
Urticaceae
Boehmeria sp.
Viscaceae
Viscum articulatum

Lysiana subfalcata **415** **89**

Apocynaceae
Nerium oleander *
Caesalpiniaceae
Bauhinia carronii
Bauhinia cunninghamii
Cassia sp.
Lysiphyllum carronii
Lysiphyllum cunninghamii
Lysiphyllum gilvum
Senna artemisioides
Capparaceae
Apophyllum anomalum
Capparis lasiantha
Capparis loranthifolia
Capparis mitchellii
Casuarinaceae
Allocasuarina decaisneana
Casuarina cristata
Casuarina glauca
Celastraceae
Denhamia obscura
Maytenus cunninghamii
Euphorbiaceae
Excoecaria agallocha
Excoecaria parvifolia
Petalostigma pubescens
Loranthaceae
Amyema preissii
Malvaceae
Thespesia sp.
Meliaceae
Azadirachta indica *
Owenia acidula
Mimosaceae
Acacia acradenia
Acacia aneura
Acacia burrowii
Acacia cana
Acacia chisholmii
Acacia colletioides
Acacia coriacea
Acacia deanei
Acacia doratoxylon
Acacia excelsa
Acacia farnesiana
Acacia hemsleyi
Acacia holosericea
Acacia ligulata
Acacia longispicata
Acacia murrayana
Acacia nilotica
Acacia oraria
Acacia oswaldii
Acacia peuce
Acacia sericata
Acacia sessiliceps
Acacia shirleyi
Acacia simsii
Acacia stenophylla
Acacia tumida
Acacia uncifera
Acacia undoolyana
Acacia victoriae
Archidendropsis basaltica *
Moraceae
Ficus opposita
Myoporaceae
Eremophila duttonii
Myrtaceae
Angophora costata
Eucalyptus brachyandra
Eucalyptus brownii
Eucalyptus clarksoniana
Eucalyptus longifolia
Eucalyptus polycarpa
Eucalyptus populnea
Lysicarpus angustifolius
Melaleuca leucadendra
Pittosporaceae
Bursaria spinosa
Pittosporum phylliraeoides
Polygonaceae
Muehlenbeckia cunninghamii
Proteaceae
Grevillea parallela
Grevillea parviflora
Grevillea sessilis
Grevillea striata
Hakea ivoryi
Hakea leucoptera
Hakea lorea
Rhizophoraceae
Rhizophora mucronata
Rubiaceae
Canthium oleifolium
Gardenia resinosa

Rubiaceae cont.
Psydrax lamprophylla
Rutaceae
Citrus limon *
Eremocitrus glauca
Flindersia collina
Geijera parviflora
Santalaceae
Exocarpos cupressiformis
Santalum acuminatum
Santalum lanceolatum
Sapindaceae
Alectryon forsythii
Alectryon oleifolius
Atalaya hemiglauca
Sapotaceae
Pouteria sericea
Urticaceae
Boehmeria sp.
Zygophyllaceae
Nitraria billardierei

Muellerina bidwillii **60** **6**

Cupressaceae
Callitris columellaris
Callitris endlicheri
Callitris glaucophylla
Callitris preissii
Callitris rhomboidea
Fabaceae
Chamaecytisus palmensis *

Muellerina celastroides **194** **43**

Anacaridaceae
Schinus areira *
Apocynaceae
Nerium oleander *
Araliaceae
Astrotricha floccosa
Araucariaceae
Araucaria heterophylla
Casuarinaceae
Allocasuarina littoralis
Allocasuarina torulosa
Casuarina sp.
Epacridaceae
Acrotriche aggregata
Fabaceae
Robinia pseudoacacia *
Fagaceae
Quercus alba *
Quercus vigineriana *
Lauraceae
Cryptocarya laevigata
Litsea reticulata
Loranthaceae
Amyema miquelii
Dendrophthoe vitellina
Muellerina eucalyptoides
Magnoliaceae
Magnolia grandiflora *
Meliaceae
Melia azedarach
Synoum glandulosum
Mimosaceae
Acacia sp.
Moraceae
Ficus sp.
Myrtaceae
Acmena smithii
Angophora floribunda
Myrtaceae cont.
Callistemon lanceolatus
Eucalyptus blakelyi
Eucalyptus calophylla
Eucalyptus camaldulensis
Eucalyptus polyanthemos
Eucalyptus tereticornis
Syncarpia glomulifera
Platanaceae
Platanus orientalis *
Proteaceae
Banksia aemula
Banksia integrifolia
Banksia marginata
Banksia serrata
Hakea salicifolia
Macadamia sp.
Persoonia sp.
Rosaceae
Malus domestica *
Photinia serrulata *
Prunus armeniaca *
Prunus domestica *
Prunus persica *
Pyrus communis *
Rutaceae
Acronychia imperforata
Citrus limon *
Santalaceae
Exocarpos cupressiformis
Sapindaceae
Harpullia pendula

Muellerina eucalyptoides **336** **115**

Anacaridaceae
Schinus areira *
Apocynaceae
Nerium oleander *
Casuarinaceae
Allocasuarina littoralis
Allocasuarina torulosa
Allocasuarina verticillata
Casuarina glauca
Celastraceae
Euonymus japonicus *
Cupressaceae
Callitris endlicheri
Fabaceae
Chamaecytisus palmensis *
Fagaceae
Quercus humilis *
Quercus robur *

Loranthaceae
Lysiana exocarpi
Muellerina celastroides
Muellerina eucalyptoides
Magnoliaceae
Magnolia grandiflora *
Meliaceae
Melia azedarach
Mimosaceae
Acacia adunca
Acacia baileyana
Acacia binervata
Acacia decurrens
Acacia ferominens
Acacia floribunda
Acacia fulva
Acacia implexa
Acacia linifolia
Acacia mearnsii
Acacia melanoxylon
Acacia paradoxa
Acacia prominens
Myrtaceae
Angophora bakeri
Angophora costata
Angophora floribunda
Angophora hispida
Angophora subvelutina
Callistemon lanceolatus
Callistemon viminalis
Eucalyptus acmenoides
Eucalyptus agglomerata
Eucalyptus amplifolia
Eucalyptus andrewsii
Eucalyptus bancroftii
Eucalyptus baueriana
Eucalyptus baxteri
Eucalyptus blakelyi
Eucalyptus bridgesiana
Eucalyptus calophylla
Eucalyptus camaldulensis
Eucalyptus crebra
Eucalyptus cypellocarpa
Eucalyptus dealbata
Eucalyptus dwyeri
Eucalyptus eugenioides
Eucalyptus eximia
Eucalyptus ficifolia
Eucalyptus goniocalyx
Eucalyptus grandis
Eucalyptus gummifera
Eucalyptus haemastoma
Eucalyptus intermedia
Eucalyptus laevopinea
Eucalyptus longifolia
Eucalyptus maculata
Eucalyptus mannifera
Eucalyptus melanophloia
Eucalyptus melliodora
Eucalyptus moluccana
Eucalyptus muelleriana
Eucalyptus notabilis
Eucalyptus obliqua
Eucalyptus ovata
Eucalyptus paniculata
Eucalyptus parramattensis
Eucalyptus parvula
Eucalyptus pauciflora
Eucalyptus pilularis
Eucalyptus piperita
Eucalyptus polyanthemos
Eucalyptus prava
Eucalyptus propinqua
Eucalyptus punctata
Eucalyptus racemosa
Eucalyptus resinifera
Eucalyptus rossii
Eucalyptus saligna
Eucalyptus scoparia
Eucalyptus siderophloia
Eucalyptus sideroxylon
Eucalyptus sieberi
Eucalyptus sparsifolia
Eucalyptus squamosa
Eucalyptus tereticornis
Eucalyptus umbra
Eucalyptus viminalis
Eucalyptus wardii
Eucalyptus willisii
Kunzea ambigua
Kunzea ericoides
Leptospermum trinervium
Leptospermum laevigatum
Leptospermum polygalifolium
Melaleuca ericifolia
Melaleuca linariifolia
Melaleuca styphelioides
Platanaceae
Platanus orientalis *
Rosaceae
Crataegus monogyna *
Crataegus oxyacantha *
Photinia serrulata *
Prunus armeniaca *
Prunus avium *
Prunus domestica *
Prunus persica *
Pyrus communis *
Santalaceae
Exocarpos cupressiformis
Sterculiaceae
Brachychiton populneus
Ulmaceae
Ulmus procera *

Muellerina myrtifolia **24** **4**

Bignoniaceae
Pandorea jasminoides
Casuarinaceae
Allocasuarina littoralis

Euphorbiaceae
Croton phebalioides
Myrtaceae
Kunzea ericoides
Oleaceae
Notelaea sp.

VISCACEAE

Korthalsella breviarticulata **8** **4**

Euphorbiaceae
Croton insularis
Rutaceae
Citrus aurantium *
Geijera salicifolia
Sapindaceae
Alectryon diversifolius

Korthalsella disticha **4** **1**

Oleaceae
Nestegis ligustrina *
Rutaceae
Citrus sp. *

Korthalsella emersa **8** **3**

Celastraceae
Elaeodendron curtipendulum
Lauraceae
Cryptocarya triplinervis
Oleaceae
Olea paniculata

Korthalsella grayi **12** **0**

No recorded host species

Korthalsella japonica **20** **8**

Epacridaceae
Acrotriche baileyana
Grossulariaceae
Polyosma sp.
Myrsinaceae
Rapanea porosa
Myrtaceae
Austromyrtus fragreantissima
Backhousia bancroftii
Eugenia sp.
Rhodomyrtus sericea
Rutaceae
Acronychia chooreechillum
Geijera parviflora
Geijera salicifolia

Korthalsella leucothrix **18** **4**

Mimosaceae
Acacia acuminata
Acacia aneura
Acacia craspedocarpa
Acacia ramulosa

Korthalsella papuana **14** **2**

Lauraceae
Cinnamomum propinquum
Myrtaceae
Acmena sp.
Eugenia sp.
Syzygium oleosum

Korthalsella rubra **122** **22**

Apocynaceae
Alyxia ruscifolia
Capparaceae
Capparis mitchellii
Celastraceae
Cassine australis
Elaeodendron sp.
Ebenaceae
Diospyros ferrea
Elaeagnaceae
Elaeocarpus ferruginiflorus
Elaeocarpaceae
Sloanea australis
Epacridaceae
Trochocarpa lauirna
Lauraceae
Cryptocarya triplinervis
Monimiaceae
Doryphora sassafras
Myoporaceae
Eremophila mitchellii
Myrtaceae
Acmena brachyandra
Acmena smithii
Archirhodomyrtus beckleri
Callistemon viminalis
Eugenia sp.
Lophostemon laurina
Melaleuca ericifolia
Syzygium oleosum
Oleaceae
Notelaea microcarpa
Rosaceae
Prunus persica *
Rutaceae
Geijera parviflora
Geijera salicifolia
Solanaceae
Lycium sp.
Xanthophyllaceae
Xanthophyllum octandrum

Notothixos cornifolius **105** **8**

Rutaceae
Zantnoxylum pinnatum
Sapindaceae
Jagera pseudorhus
Sterculiaceae
Argyrodendron peralatum
Argyrodendron trifoliolatum
Brachychiton diversifolius

Sterculiaceae cont.		
Brachychiton populneus		
Francisodendron laurifolia		
Heritiera trifoliolata		
Notothixos incanus	**60**	**12**
Loranthaceae		
Amyema congener		
Myrtaceae		
Callistemon salignus		
Callistemon viminalis		
Melaleuca bracteata		
Melaleuca decora		
Melaleuca foliolosa		
Melaleuca irbyana		
Melaleuca linariifolia		
Melaleuca quinquenervia		
Melaleuca sieberi		
Melaleuca styphelioides		
Melaleuca viridiflora		
Notothixos leiophyllus	**49**	**8**
Burseraceae		
Canarium australianum		
Cunoniaceae		
Pullea stutzeri		
Meliaceae		
Toona australis		
Myrtaceae		
Syzygium johnsonii		
Rutaceae		
Acronychia acidula		
Acronychia acronychioides		
Brombya platynema		
Flindersia acuminata		
Notothixos subaureus	**237**	**35**
Burseraceae		
Canarium australasicum		
Casuarinaceae		
Allocasuarina littoralis		
Casuarina cunninghamiana		
Casuarina glauca		
Lauraceae		
Cryptocarya sp.		
Litsea ferruginea		
Litsea leefeana		
Loranthaceae		
Amyema bifurcata		
Amyema cambagei		
Amyema congener		
Amyema linophylla		
Amyema miquelii		
Amyema pendula		
Amyema queenslandica		
Amylotheca dictyophleba		
Dendrophthoe curvata		
Dendrophthoe falcata		
Dendrophthoe glabrescens		
Dendrophthoe vitellina		
Lysiana casuarinae		
Lysiana exocarpi		
Muellerina celastroides		
Muellerina eucalyptoides		
Mimosaceae		
Acacia sp.		
Myrtaceae		
Angophora subvelutina		
Eucalyptus pilularis		
Lophostemon suaveolens		
Syncarpia sp.		
Proteaceae		
Grevillea robusta		
Rutaceae		
Acronychia acidula		
Acronychia imperforata		
Acronychia laevis		
Acronychia littoralis		
Acronychia vestita		
Melicope elleryana		
Sterculiaceae		
Brachychiton populneus		
Viscaceae		
Notothixos incanus		
Viscum articulatum		
Viscum articulatum	**201**	**28**
Anacaridaceae		
Buchanania obovata		
Casuarinaceae		
Allocasuarina littoralis		
Casuarina cunninghamiana		
Casuarina glauca		
Chrysobalanaceae		
Parinari nonda		
Loranthaceae		
Amyema bifurcata		
Amyema cambagei		
Amyema congener		
Amyema miquelii		
Amylotheca dictyophleba		
Decaisnina angustata		
Decaisnina brittenii		
Decaisnina signata		
Dendrophthoe falcata		
Dendrophthoe glabrescens		
Dendrophthoe homoplastica		
Dendrophthoe vitellina		
Lysiana spathulata		
Lysiana subfalcata		
Mimosaceae		
Acacia aulacocarpa		
Myrtaceae		
Angophora costata		
Eucalyptus populnea		
Eugenia sp.		
Lophostemon confertus		
Melaleuca sp.		
Syzygium suborbiculare		

Rutaceae		
Citrus limon *		
Santalaceae		
Exocarpos cupressiformis		
Exocarpos latifolius		
Viscaceae		
Notothixos subaureus		
Viscum bancroftii	**7**	**1**
Casuarinaceae		
Casuarina sp.		
Loranthaceae		
Amyema quandang		
Viscum ovalifolium	**21**	**4**
Apocynaceae		
Ichnocarpus frutescens		
Euphorbiaceae		
Croton arnhemicus		
Moraceae		
Ficus sp.		
Tiliaceae		
Grewia papuana		
Ulmaceae		
Celtis philippinensis *		
Viscum whitei	**29**	**8**
Anacaridaceae		
Buchanania obovata		
Combretaceae		
Terminalia canescens		
Loranthaceae		
Amyema bifurcata		
Amyema sanguinea		
Decaisnina brittenii		
Dendrophthoe acacioides		
Myrtaceae		
Eucalyptus arenaria		
Eucalyptus populnea		

Native and exotic flora of the North Western Slopes upstream of the junction of the Peel and Namoi Rivers, New South Wales

J.R. Hosking and T.A. James

Hosking[1], J.R. and T.A. James[2] ([1] NSW Agriculture and CRC for Weed Management Systems, RMB 944, Tamworth, NSW 2340; [2]National Herbarium of New South Wales, Royal Botanic Gardens Sydney, Mrs Macquaries Road, Sydney, NSW 2000) 1998. Native and exotic flora of the North Western Slopes upstream of the junction of the Peel and Namoi Rivers, New South Wales. Cunninghamia *5(3): 721–766.* The area covered by this study is in the North Western Slopes botanical subdivision of New South Wales, upstream of the junction of the Peel and Namoi Rivers (between 30°16'S and 31°35'S and 150°21'E and 151°22'E). Detailed surveys were carried out in eight areas on a range of soils. A total of 1041 taxa (1016 species) were recorded (639 native to the area, 8 Australian but not native to the area, 394 exotic and naturalised). Data were analysed to provide relative proportions of native and exotic plant taxa in relation to plant groups, plant families, survey sites, and life-form and life-cycle attributes. A high proportion of exotic taxa (38%) was recorded, particularly in the plant families Poaceae, Asteraceae and Fabaceae, reflecting a long history of settlement and agriculture in the region. A diversity of life-forms was represented but overall the taxa were predominantly forbs, grasses or grass-like plants. The area around Woodsreef asbestos mine and an area east of Chaffey Dam contained a number of native species that appeared to be restricted to serpentinite areas. The threat of invasion and replacement of native species by exotic species is a serious problem in the study area. The only conservation reserves are found in dissected country on the eastern side, the largest being Warrabah National Park which recorded the highest number of native taxa (351). The authors know of no fertile, gently-sloping areas which have not been modified by many years of grazing or cropping. In these areas the least disturbed native vegetation is found along some stock routes and roadsides. A more comprehensive reserve system is clearly needed to protect the range of vegetation communities existing in the study area.

Introduction

The aim of this study is to improve documentation of the North Western Slopes flora upstream of the junction of the Peel and Namoi Rivers, and to analyse and compare the native and exotic flora of this region. The study area is in the south-eastern corner of the North Western Slopes botanical subdivision which extends from the Queensland border west of Tenterfield south-west to the Warrumbungles. The only previously published flora for a location in the study area covers Oxley Park, Tamworth (Hosking 1990, 1991). Jurjens (1974) lists some of the species found in the Tamworth-Nundle-'Head of Peel' area in the southern part of this study. Williams (1979) lists plants recorded in pastures of the North Western Slopes. White et al. (1990) studied vegetation which would be flooded by an enlargement of Chaffey Dam and listed some of the species found in the southern part of this study and at site 8 listed below. Our study updates the Oxley Park list and provides floristic records at seven other sites. Documentation is fundamental to improving our knowledge of the frequency and distribution of native and exotic plant taxa, with important practical applications in many aspects of vegetation management.

The study area

The study area is approximately 620 000 ha situated to the north of Sydney and west of the Great Dividing Range (Fig. 1). Larger towns in this area, from north to south, are Barraba, Manilla, Tamworth and Nundle. The area varies in altitude from about 290 m above sea level (asl) at the junction of the Peel and Namoi Rivers to around 950 m asl on some of the higher peaks such as Black Jack Mountain about 6 km north west of Chaffey Dam.

The climate is similar to that of Tamworth (described in Hosking 1990). Over the survey area it is generally warmer moving from east to west and wetter moving toward the mountains on the eastern boundary and south towards Nundle. Table 1 shows long term average rainfall for Barraba, Manilla, Tamworth and Nundle, and long term average temperatures (maximum and minimum) for Barraba and Tamworth.

Table 1. Mean monthly rainfall and temperature for selected stations on the North Western Slopes of New South Wales.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Barraba[†]	87	77	57	39	43	47	44	40	44	63	72	74	687
Manilla[*]	91	68	56	40	42	45	42	40	40	59	65	74	658
Tamworth[†]	85	66	49	41	43	50	45	46	48	60	67	71	671
Nundle[*]	98	79	59	50	56	75	70	68	64	78	79	93	864
Temperature (°C)													
Barraba[†]													
(Max.)	31.2	30.9	28.8	25.2	20.2	16.6	15.9	17.7	20.7	24.5	27.6	30.6	24.2
(Min.)	16.3	16.0	12.8	7.7	4.0	1.5	-0.1	1.3	4.0	8.2	11.3	14.3	8.1
Tamworth[†]													
(Max.)	31.0	30.8	28.6	24.8	19.6	16.3	15.2	17.0	20.3	24.2	27.7	30.3	23.8
(Min.)	17.4	17.2	15.0	11.2	7.2	4.6	3.1	4.3	6.6	10.3	13.4	16.1	10.5

[†] Based on Anon. (1988)

[*] From MetAccess © CSIRO — Manilla Post Office readings from 1883–1994, Nundle Post Office readings from 1890–1992.

The most widespread plant communities in the area were originally *Eucalyptus* woodlands but, following settlement in the late 1820s and early 1830s, there was clearing for sheep and cattle grazing (Milliss 1980). More recently the gently sloping to flat areas have been cultivated for winter and summer crops.

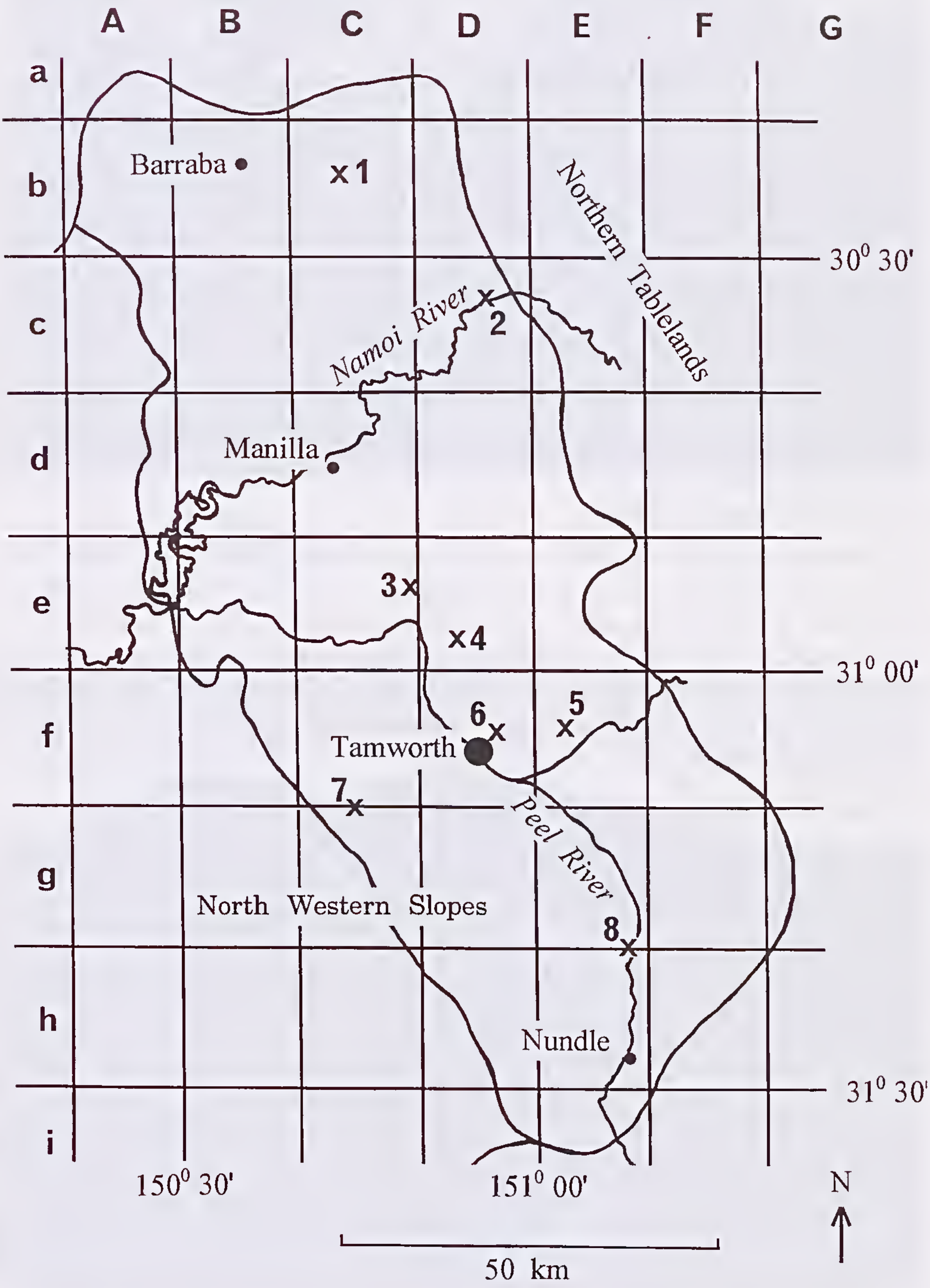

Fig. 1. Map of the study area upstream of the junction of the Peel and Namoi Rivers. Detailed survey sites are listed 1 to 8 with sites of other collections listed Aa to Ei.

Methods

Eight sites, on a range of substrates and soils, were selected for detailed survey. Ease of access was a factor in site choice. Sites were of variable size because some of the substrates occurred as small outcrops. In one case an area alongside a road was used, as such areas are the only ones where relatively undisturbed native vegetation can be found on black cracking clay soil. Surveys were carried out to determine which species were present at each site and involved detailed searches of as much of each site as was possible. Fixed quadrats were not used as this would have missed many of the less widespread species. Collections outside the eight primary sites were only made on an ad hoc basis. If a number of species not encountered at the eight detailed study sites was found at any other location then this location was also visited on a number of occasions. For this reason a number of visits were made to wet gullies south-east of Chaffey Dam, a serpentinite area east of Chaffey Dam and a roadside area near Klori (west of Attunga Rubbish Tip). Species recorded were those native to the area or species that have become naturalised.

The flora lists for Oxley Park, Attunga State Forest and Warrabah National Park were largely compiled between January 1984 and March 1997. The area near Kootingal was surveyed from April 1989 and the other four sites from August 1992. Sampling was carried out during all seasons.

Specimens of most taxa were sent to the National Herbarium of New South Wales (NSW) for confirmation. Many of these specimens have been retained by NSW and duplicates are held at the Tamworth Agricultural Research Centre Herbarium. Further specimens have been lodged at the New England Herbarium (NE), the Australian National Herbarium (CANB) and the National Herbarium of Victoria (MEL). Lodging of voucher specimens at these herbaria is essential in view of ongoing taxonomic research and reviews.

Each species was assessed for life form, origin (native or exotic) and life cycle (for more details see Table 2) and the information was entered into a Microsoft Access database for data manipulation.

Study sites

Sites studied in detail are described below. Plant communities described follow those of Specht (1970) and are those presently on the sites.

1. Woodsreef asbestos mine

The area of this site (between 30°23'S and 30°26'S and 150°43'E and 150°45'E) covered approximately 150 ha around Woodsreef asbestos mine. Altitude varied from 465 m to 600 m. There has been little disturbance between the road, on the eastern side, and the open cut mine. This area does not appear to have been grazed for many years (Fig. 2). Grazing occurs to the west of the mine but this decreases with distance from Ironbark Creek and with increasing steepness of slopes. Soil in the survey area is predominantly derived from serpentinite. Vegetation is mainly grassy woodland. The dominant tree species in the area is a stringybark, *Eucalyptus* sp. (previously confused with

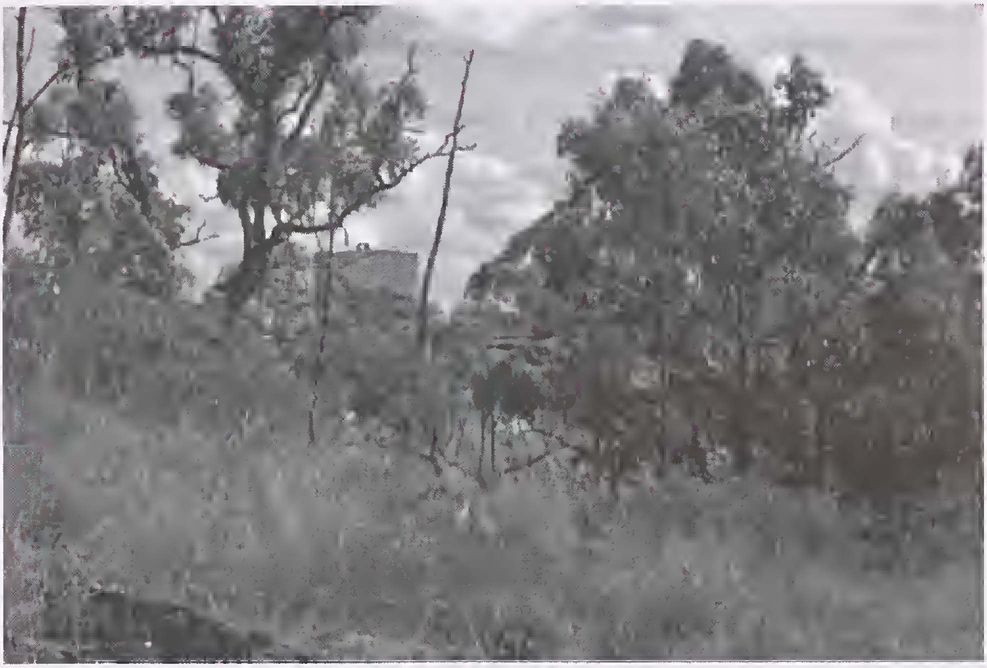

Fig. 2. Woodland of *Eucalyptus* sp. (unnamed stringybark) with scattered *Angophora floribunda* near Woodsreef asbestos mine (Site 1).

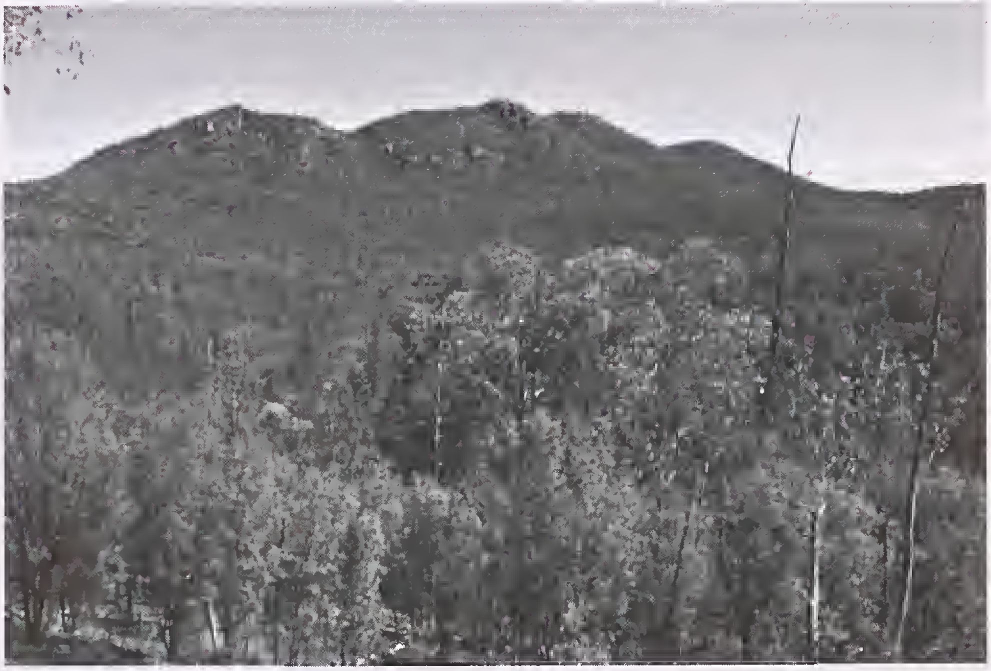

Fig. 3. Warrabah National Park mainly consists of woodland to open-forest communities dominated by *Callitris glaucophylla* and *Eucalyptus* species (Site 2).

Eucalyptus macrorhyncha). Scattered trees of *Angophora floribunda* also occur in this area and *Xanthorrhoea glauca* is locally common south of the mine. The shrub understorey is commonly sparse and the ground flora is dominated by perennial grasses such as *Aristida ramosa*. One area east of the mine consists of a north-facing slope dominated by *Triodia scariosa*. The survey included sampling along Ironbark Creek where soils are derived from a mixture of serpentinite, basalt, jasper and quartz.

Table 2 Species list for North Western Slopes upstream of the junction of the Peel and Namoi Rivers.

Nomenclature follows Harden (1990–93) except where indicated.

Before the species

* exotic species

† native species which is probably not, or definitely not, native to this area

‡ species not recorded as present in the North Western Slopes in Harden (1990–93)

Life form

C = climber or creeper
E = epiphyte
e = epilith (plants growing on rocks)
F = forb
G = grasses
GL = grass-like
HP = hemiparasite
LS= low shrub (< 2 m high)
P = parasite
Pt = Pteridophyte
TS = tall shrub (> 2 m high)
T = tree

Life cycle

AN = annual
PA = perennial bulb with annual shoots
PE = perennial
SP = short-lived perennial

Site

1 = Woodsreef asbestos mine
2 = Warrabah National Park
3 = Attunga rubbish tip
4 = Attunga State Forest
5 = Kootingal
6 = Oxley Park, Tamworth
7 = Duri
8 = Chaffey Dam

Other = areas correspond to grids shown on Fig. 1.

v = a plant specimen from this site was checked by NSW, some have been retained by NSW and others are often located at other herbaria (see text).

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
PTERIDOPHYTES											
ADIANTACEAE											
Adiantum aethiopicum	Pt	PE	-	2	-	4	5	6v	-	8	
Adiantum hispidulum	Pt	PE	-	2v	-	4v	5	-	-	-	
ASPLENIACEAE											
Asplenium flabellifolium	Pt	PE	1	2v	-	4v	5	6v	-	8	
Pleurosorus subglandulosus	Pt	PE	-	2v	-	4v	5	-	-	8	
AZOLLACEAE											
Azolla filiculoides var. _rubra_	Pt	PE	1	2v	-	-	-	-	-	8	
BLECHNACEAE											
Doodia media subsp. _media_	Pt	PE	-	2v	-	-	-	-	-	-	
DENNSTAEDTIACEAE											
Pteridium esculentum	Pt	PE	-	-	-	-	-	6v	-	8	
DRYOPTERIDACEAE											
Polystichum fallax	Pt	PE	-	-	-	-	-	-	-	-	Ehv
MARSILEACEAE											
Marsilea drummondii	Pt	AN	-	2v	-	-	-	-	-	-	
POLYPODIACEAE											
Pyrrosia confluens	E,e,Pt	PE	-	-	-	-	-	-	-	-	Ehv
Pyrrosia rupestris	E,e,Pt	PE	-	-	-	-	-	-	-	8v	
PTERIDACEAE											
Pteris tremula	Pt	PE	-	2v	-	-	-	-	-	8v	
SINOPTERIDACEAE											
Cheilanthes distans	Pt	PE	1	2v	3	4v	5	6v	-	8	
Cheilanthes sieberi subsp. _sieberi_	Pt	PE	1	2v	3	4	5	6v	-	8	
Pellaea falcata var. _falcata_	Pt	PE	-	2	-	4	5	6v	-	8	
TAENITIDACEAE											
Anogramma leptophylla	Pt	AN	-	2v	-	-	-	-	-	-	
CYCADS											
ZAMIACEAE											
Macrozamia stenomera	LS	PE	-	2v	-	4v	-	6v	-	-	
CONIFERS											
CUPRESSACEAE											
Callitris endlicheri	T	PE	-	2v	-	-	-	-	-	-	
Callitris glaucophylla	T	PE	1	2	3	4	5	6v	-	-	
‡*_Sabina virginiana_	T	PE	-	-	-	-	-	6v	-	-	
MONOCOTYLEDONS											
AGAVACEAE											
*_Agave americana_	TS	PE	-	-	-	4	-	-	-	-	
ALLIACEAE											
*_Nothoscordum borbonicum_	GL	PA	-	2	-	-	-	6v	-	8	
AMARYLLIDACEAE											
Crinum flaccidum	GL	PA	-	-	3v	-	5	-	-	-	
‡*_Narcissus tazetta_	GL	PA	-	-	-	-	-	-	-	-	Ehv
‡*_Narcissus tazetta_ 'double'	GL	PA	-	-	-	-	-	-	-	-	Ehv
ANTHERICACEAE											
Arthropodium minus	GL	PA	1	2	3	4v	5	6v	7	8	
Arthropodium sp. B	GL	PA	1	2	3	4	5	6v	-	8v	
Caesia calliantha	GL	PA	-	-	-	-	-	-	7v	-	
Dichopogon fimbriatus	GL	PA	-	2	3	4	5	6v	7	8	
Laxmannia gracilis	GL	PA	1v	2v	-	-	-	-	-	-	
Thysanotus tuberosus	GL	PA	1v	-	-	-	-	6	-	-	
Tricoryne elatior	GL	PA	1v	2v	-	-	-	-	-	8	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
ARECACEAE											
‡**Phoenix canariensis*	T	PE	-	-	-	4	-	6v	-	-	
ASPARAGACEAE											
**Asparagus asparagoides* (= *Myrsiphyllum asparagoides*)	C	PA	-	-	-	-	-	6v	-	-	
‡**Asparagus densiflorus* (= *Protasparagus aethiopicus*)	F	PA	-	-	-	-	-	6	-	-	
**Asparagus officinalis*	F	PA	1	-	-	-	-	6v	-	-	
ASPHODELACEAE											
**Aloe saponaria*	F	PE	-	-	-	-	-	6v	-	-	
**Asphodelus fistulosus*	GL	SP	1	-	3	4	-	6v	7	-	
‡*Bulbine alata*	GL	AN	-	-	-	-	-	-	-	-	Bdv
Bulbine bulbosa	GL	PE	-	2	3	4v	-	6v	7	8	
Bulbine semibarbata	GL	AN	-	-	-	4v	-	-	-	-	
CENTROLEPIDACEAE											
Centrolepis strigosa	GL	AN	-	2v	-	-	-	-	-	-	
COLCHICACEAE											
Wurmbea biglandulosa	GL	PA	1v	2v	3	4v	5	6v	-	8	
COMMELINACEAE											
Commelina cyanea	F	PE	1v	2	-	4	5	6v	-	8v	
Murdannia graminea	GL	PA	-	2v	-	-	-	-	-	-	
**Tradescantia albiflora*	F	PE	-	-	-	-	-	6v	-	-	
**Tradescantia zebrina*	F	PE	-	-	-	-	-	6v	-	-	
CONVALLARIACEAE											
‡**Liriope* (possibly *L. muscari*)	GL	PA	-	-	-	-	-	6v	-	-	
CYPERACEAE											
‡*Bolboschoenus fluviatilis*	GL	PE	-	-	-	-	-	-	-	-	Bev
‡*Bolboschoenus medianus*	GL	PE	-	2	-	-	-	-	-	-	Dfv
Bulbostylis barbata	GL	AN	-	2v	-	-	-	-	-	-	
Carex appressa	GL	PE	1v	2v	-	4	-	-	-	8v	
Carex breviculmis	GL	PE	1v	2v	-	-	-	-	-	8v	
Carex fascicularis	GL	PE	-	-	-	-	-	-	-	8v	
Carex incomitata	GL	PE	1	2	-	4	-	6v	-	8	
Carex inversa	GL	PE	1	2	3	4v	5	6v	7v	8	
‡*Carex longebrachiata*	GL	PE	-	-	-	-	-	-	-	-	Eiv
Carex polyantha	GL	PE	-	2v	-	-	-	-	-	-	
**Cyperus aggregatus*	GL	AN	-	-	-	-	5v	-	-	-	
Cyperus concinnus	GL	PE	1v	-	-	4v	-	-	-	-	
Cyperus difformis	GL	AN	-	2v	-	4	-	-	-	8v	
**Cyperus eragrostis*	GL	PE	-	2v	-	-	5	-	-	8	
Cyperus exaltatus	GL	PE	-	2v	-	-	-	-	-	-	
‡**Cyperus flavescens*	GL	AN	1v	-	-	-	-	-	-	-	
Cyperus flavidus	GL	SP	1v	-	-	4v	-	-	-	8	
Cyperus fulvus	GL	PE	1v	2v	-	4	5	-	-	-	
Cyperus gracilis	GL	PE	1	2	3	4	5	6v	-	8	
Cyperus gunnii subsp. *gunnii*	GL	PE	-	2v	-	-	-	-	-	-	
Cyperus lhotskyanus	GL	PE	1v	2v	-	-	-	-	-	-	
Cyperus lucidus	GL	PE	-	2v	-	-	-	-	-	-	
Cyperus polystachyos	GL	SP	1v	-	-	-	-	-	-	-	
‡*Cyperus pygmaeus*	GL	AN	-	-	-	-	-	-	-	-	Bdv
**Cyperus rotundus*	GL	PE	-	-	3	-	5	6v	7	8v	
Cyperus sanguinolentus	GL	SP	1v	2v	-	-	-	-	-	8	
Cyperus sphaeroideus	GL	PE	1	2v	-	-	-	-	-	8	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Cyperus trinervis	GL	PE	-	2v	-	-	-	-	-	-	
Cyperus vaginatus	GL	PE	1	2	-	4	-	6v	-	8	
Eleocharis acuta	GL	PE	-	2v	-	-	-	-	-	-	
Eleocharis cylindrostachys	GL	PE	-	2v	-	-	-	-	-	-	
Eleocharis plana	GL	PE	-	-	-	-	-	-	-	-	Dfv
Eleocharis pusilla	GL	PE	-	2v	-	-	-	-	-	8v	
Fimbristylis dichotoma s. lat.	GL	PE	-	2v	-	4v	5	-	-	-	
‡*Fimbristylis velata*	GL	AN	-	-	-	-	-	-	-	-	Bdv
‡*Isolepis cernua*	GL	PE	-	-	-	-	-	-	-	-	Ehv
Isolepis hookeriana	GL	AN	-	2v	-	4v	-	-	-	8	
Lepidosperma laterale	GL	PE	1	2v	-	4v	-	-	-	8	
Lipocarpha microcephala	GL	AN	-	2v	-	-	-	-	-	-	
‡**Schoenoplectus lineolatus*	GL	PE	-	2v	-	-	-	-	-	-	
Schoenoplectus mucronatus	GL	PE	-	2v	-	-	-	-	-	-	
Schoenoplectus validus	GL	PE	1	2	-	4v	-	-	-	8	
Schoenus apogon	GL	AN	1v	2v	-	4v	-	6v	-	8	
Schoenus centralis	GL	AN	1v	-	-	-	-	-		-	
Scleria mackaviensis	GL	PE	1v	2	-	4	-	6v	-	8	
GEITONOPLESIACEAE											
Eustrephus latifolius	C	PE	1	2	3	4	-	6v	-	8	
‡*Geitonoplesium cymosum*	C	PE	-	-	-	-	-	-	-	-	Egv
HYDROCHARITACEAE											
Ottelia ovalifolia	F	PE	-	-	-	-	-	-	-	-	Eg
‡*Vallisneria gigantea*	F	PE	-	2v	-	-	-	-	-	-	
HYPOXIDACEAE											
Hypoxis hygrometrica	GL	PA	-	2v	-	4v	-	-	-	-	
IRIDACEAE											
‡**Freesia* hybrid	GL	PA	-	-	-	-	-	6v	-	-	
‡**Gladiolus carneus*	GL	PA	-	-	-	-	-	-	-	-	Cfv
**Iris germanica*	GL	PE	-	-	-	-	-	6	-	-	
Patersonia sericea var. *sericea*	GL	PE	-	2v	-	-	-	-	-	-	
**Romulea minutiflora*	GL	PA	-	-	-	-	-	-	-	-	Egv
‡**Romulea rosea* var. *australis*	GL	PA	-	-	-	-	-	-	-	-	Dfv
‡**Sisyrinchium iridifolium*	GL	SP	-	-	-	-	-	-	-	-	Ehv
**Sisyrinchium* sp. A	GL	AN	-	2v	-	4v	-	-	-	-	
JUNCACEAE											
**Juncus articulatus*	GL	PE	1v	-	-	4	-	6v	-	8	
**Juncus bufonius*	GL	AN	1v	-	-	4	-	-	-	8v	
**Juncus capitatus*	GL	AN	-	2v	-	-	-	-	-	-	
Juncus filicaulis	GL	PE	-	-	-	-	-	-	-	8v	
Juncus filicaulis × *J. subglaucus* (probably, according to NSW)	GL	PE	-	-	-	-	-	-	-	-	Cgv
Juncus firmus	GL	PE	1v	-	-	4v	-	-	-	8v	
Juncus homalocaulis	GL	PE	-	2v	-	4v	-	-	-	8v	
Juncus ochrocoleus	GL	PE	-	2v	-	-	-	-	-	-	
Juncus prismatocarpus	GL	PE	-	2v	-	-	-	-	-	-	
Juncus subglaucus	GL	PE	-	-	-	-	-	-	7v	-	
Juncus subsecundus	GL	PE	-	2v	-	4v	-	-	-	-	
Juncus subsecundus × *J. aridicola*	GL	PE	1v	-	-	-	-	-	-	-	
Juncus usitatus	GL	PE	-	2v	-	-	-	6v	-	-	
Juncus usitatus × *J. subglaucus* (probably, according to NSW)	GL	PE	-	-	-	-	-	6v	-	-	
Juncus vaginatus	GL	PE	-	2v	-	4v	-	-	-	-	
Luzula densiflora	GL	PE	-	-	-	-	5v	-	-	-	
Luzula flaccida	GL	PE	-	2	-	4v	-	-	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Luzula meridionalis	GL	PE	-	-	-	-	-	6v	-	8v	
JUNCAGINACEAE											
Triglochin multifructum	F	PE	-	2v	-	-	-	-	-	-	
LEMNACEAE											
Lemna disperma	F	PE	-	2	-	-	-	-	-	-	
Spirodela punctata	F	PE	-	2v	-	4v	-	-	-	-	
LOMANDRACEAE											
Lomandra filiformis subsp. *flavior*	GL	PE	-	2v	-	-	-	-	-	-	
Lomandra filiformis subsp. *filiformis*	GLPE	1	-	-	3v	4v	5v	6v	7	8v	
Lomandra leucocephala subsp. *leucocephala*	GL	PE	-	-	-	-	-	-	-	-	Dfv
Lomandra longifolia	GL	PE	1	2	3	4	5	6v	-	8	
Lomandra multiflora subsp. *multiflora*	GL	PE	1	2	3	4v	-	6v	-	8	
ORCHIDACEAE											
Acianthus collinus	F	PA	-	2v	-	-	-	-	-	-	
‡*Bulbophyllum elisae*	E,e	PA	-	-	-	-	-	-	-	-	Ehv
Caladenia caerulea	GL	PA	-	2	-	-	-	-	-	-	
Caladenia fuscata	GL	PA	-	2v	-	-	-	-	-	-	
Caladenia sp. (undescribed, close to *C. tentaculata*)	GL	PA	-	2v	-	-	-	-	-	-	
Calochilus campestris	GL	PA	-	-	-	-	-	-	-	-	Ehv
Cymbidium canaliculatum	E,e	PE	1	2v	-	4	-	6	-	-	
‡*Cyrtostylis reniformis*	GL	PA	-	2v	-	-	-	-	-	-	
‡*Dendrobium cucumerinum*	E,e	PE	-	-	-	-	-	-	-	-	Ehv
Dendrobium linguiforme	E,e	PE	-	2v	-	-	-	-	-	-	
‡*Dendrobium tarberi*	E,e	PE	-	-	-	-	-	-	-	-	Ehv
Dipodium punctatum	F	PA	-	-	-	4	-	6	-	8v	
Dipodium variegatum	GL	PA	-	-	-	-	-	-	-	-	Ehv
Diurus abbreviata	GL	PA	-	2v	-	-	-	-	-	-	
Eriochilus cucullatus	GL	PA	-	2v	-	-	-	-	-	-	
Glossodia major	GL	PA	-	2v	-	-	-	-	-	-	
Microtis unifolia	GL	PA	-	2	-	4	5	6v	-	8	
‡*Pterostylis chaetophora*	GL	PA	-	2v	-	-	-	-	-	-	
Pterostylis curta	GL	PA	-	2v	-	4v	-	-	-	8v	
Pterostylis hamata	GL	PA	-	2v	-	4v	-	6	-	8	
Pterostylis longicurva	GL	PA	1v	-	-	4v	-	-	-	8	
Pterostylis mutica	GL	PA	-	2v	-	-	-	6v	-	-	
PHORMIACEAE											
Dianella longifolia var. *grandis*	GL	PE	-	-	3v	-	-	-	-	-	
Dianella longifolia var. *longifolia*	GL	PE	-	2	-	4	5	6	7v	8	
Dianella revoluta var. *revoluta*	GL	PE	-	2	-	-	-	6v	-	-	
Dianella sp. (unnamed)	GL	PE	1v	-	-	-	-	-	-	-	Ehv
Stypandra glauca	GL	PE	-	2v	-	-	-	-	-	-	
POACEAE											
‡**Achnathrum caudata* (= *Stipa caudata*)	G	PE	-	-	-	-	-	-	-	-	Cgv

Species	Life form	Life cycle	Site								Other
			1	2	3	4	5	6	7	8	
Agrostis aemula	G	PE	-	-	-	-	-	-	-	-	Eiv
Agrostis avenacea var. _avenacea_	G	SP	1	2	-	4	-	6v	7	8	
*_Aira cupaniana_	G	AN	1	2v	-	4v	5v	6	-	8	
Amphibromus nervosus	G	PE	-	-	-	-	-	-	7v	-	
*_Anthoxanthum odoratum_	G	PE	-	-	-	-	-	-	-	-	Ehv
Aristida leptopoda	G	PE	-	-	-	-	-	6v	7v	-	
Aristida ramosa var. _ramosa_	G	PE	1v	2v	3	4	5	6v	7	8	
Aristida ramosa var. _speciosa_	G	PE	1	2v	-	-	-	-	-	8	
Arundinella nepalensis	G	PE	1	2v	-	-	-	-	-	-	
*_Arundo donax_	G	PE	-	-	3v	-	-	-	-	-	
Austrostipa aristiglumis (= _Stipa aristiglumis_)	G	PE	-	-	-	-	-	6v	7	8	
Austrostipa ramosissima (= _Stipa ramosissima_)	G	PE	-	2v	-	-	-	-	-	-	
Austrostipa scabra subsp. _scabra_ (= _Stipa scabra_ subsp. _scabra_)	G	PE	1v	2	3	4	5v	6v	-	8	
Austrostipa setacea (= _Stipa setacea_)	G	PE	-	2v	-	4	-	6v	-	-	
Austrostipa verticillata (= _Stipa verticillata_)	G	PE	1	2	3	4	5	6v	-	8	
‡*_Avena barbata_	G	AN	-	2	3v	4	5	6	-	8	
*_Avena fatua_	G	AN	-	-	3	-	-	6v	7	-	
*_Avena ludoviciana_	G	AN	-	-	3	-	-	6v	7	-	
‡*_Avena sativa_	G	AN	-	-	3	-	-	-	-	-	
Bothriochloa biloba	G	PE	-	-	-	-	-	-	7v	-	
Bothriochloa decipiens	G	PE	-	-	-	-	-	-	-	-	Df
Bothriochloa macra	G	PE	1	2	3	4	5	6v	7v	8	
*_Briza maxima_	G	AN	-	2	-	-	-	6v	-	-	
*_Briza minor_	G	AN	1	2	-	4v	5	6v	-	8	
*_Bromus alopecuros_	G	AN	-	-	3	-	5	-	7v	-	
Bromus arenarius	G	AN	1	-	-	-	5	-	7v	-	
*_Bromus catharticus_	G	SP	1	2	3	4	5	6v	7	8	
*_Bromus diandrus_	G	AN	-	2	3	-	5	-	7	8	Ehv
*_Bromus molliformis_	G	AN	1	2v	3	4	5	6v	7	8	
*_Bromus rubens_	G	AN	-	-	-	-	-	6v	-	-	
Capillipedium parviflorum	G	PE	-	-	-	-	-	-	-	-	Cdv-
Capillipedium spicigerum	G	PE	-	-	-	-	-	-	-	-	Cgv
*_Catapodium rigidum_	G	AN	1	-	3	4	-	6v	-	8	
Cenchrus caliculatus	G	PE	-	-	-	-	-	-	-	-	Ehv
*_Cenchrus ciliaris_	G	PE	-	2v	-	-	-	-	-	-	
*_Cenchrus incertus_	G	SP	-	2	-	4v	5v	-	-	-	
*_Chloris gayana_	G	PE	1	-	3	-	-	-	7v	8	
Chloris truncata	G	PE	1	2	3	4	5	6v	7	8	
Chloris ventricosa	G	PE	1	2	3	4	5	6v	7	8	
*_Chloris virgata_	G	SP	1	-	-	-	5	6v	-	8	
Cymbopogon obtectus	G	PE	1v	-	-	-	-	-	-	-	
Cymbopogon refractus	G	PE	1	2	3	4	5	6v	-	8	
Cynodon dactylon	G	PE	1	2	3	4	5	6v	7	8	
*_Dactylis glomerata_	G	PE	-	-	-	-	-	-	-	8v	
†_Dactyloctenium radulans_	G	PE	-	-	3	-	5	-	-	-	Dfv
Danthonia caespitosa	G	PE	-	2	-	4	5	6v	-	-	
Danthonia linkii var. _linkii_	G	PE	-	2	3	4	-	6v	7	8	
Danthonia racemosa var. _obtusata_	G	PE	-	-	-	4v	-	-	-	8	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Danthonia racemosa var. *racemosa*	G	PE	1	2	3	4	5	6v	7	8	
Danthonia richardsonii	G	PE	1	-	-	-	-	6v	-	8	
Dichanthium sericeum	G	PE	1	2v	3	4	5	6v	7	8	
Dichanthium setosum	G	PE	-	-	3	-	-	6v	7	8	
Dichelachne micrantha	G	PE	1	2	3	4	5	6v	-	8	
Digitaria brownii	G	PE	1	2v	3	4	5	6v	-	8	
**Digitaria ciliaris*	G	AN	1v	2v	3	-	5	6v	-	8v	
Digitaria diffusa	G	PE	1	2v	-	4	-	-	-	-	
Digitaria divaricatissima	G	PE	1v	-	3	4	5	6v	7	8	
Diplachne fusca	G	SP	-	-	-	-	-	-	-	-	Cev
Echinochloa colona	G	AN	1v	-	3	4v	-	6	7	8	
**Echinochloa crus-galli*	G	AN	-	2	-	4v	5	6	-	8v	
‡**Echinochloa frumentacea*	G	AN	-	-	-	-	-	-	-	-	Bev
Echinopogon intermedius	G	PE	1	2	-	4	5	6v	-	8	
Echinopogon ovatus	G	PE	1	2v	-	-	-	-	-	8	
**Ehrharta erecta*	G	PE	-	-	-	-	-	6v	-	-	
**Eleusine indica*	G	SP	-	2	3	-	5	-	-	8	Efv
**Eleusine tristachya*	G	SP	1	2	3	4	5	6v	-	8	
Elymus scaber var. *plurinervis*	G	PE	-	-	-	-	-	-	7v	-	
Elymus scaber var. *scaber*	G	PE	1	2v	3	4	5	6v	-	8	
Enneapogon gracilis	G	PE	1v	-	-	-	-	-	-	-	
Enneapogon nigricans	G	PE	-	2	3	4	5v	6v	-	8	
Enteropogon acicularis	G	PE	1	-	-	-	-	6v	-	-	
Eragrostis alveiformis (= *E. molybdea*)	G	PE	1v	-	-	-	-	-	-	-	
Eragrostis brownii	G	PE	-	2v	-	4v	5	-	-	-	
**Eragrostis cilianensis*	G	AN	1	2	3	4	5	6v	7	8	
**Eragrostis curvula*	G	PE	-	-	-	-	-	-	-	-	Dfv
Eragrostis elongata	G	SP	1	2v	-	-	-	-	-	-	
Eragrostis leptostachya	G	PE	1v	2v	-	4v	5	6v	-	8	
Eragrostis megalosperma	G	PE	-	-	-	-	-	-	-	-	Dev
Eragrostis parviflora	G	AN	-	2v	3	4v	5	6v	-	8	
‡**Eragrostis pilosa*	G	AN	-	-	-	-	-	-	-	8v	
‡**Eragrostis tef*	G	AN	-	-	-	4v	5v	-	-	-	
Eriochloa pseudoacrotricha	G	SP	1	-	3	4	5	6v	7	8	
Eulalia aurea	G	PE	-	-	-	-	-	-	7v	-	
‡*Festuca asperula*	G	PE	-	2v	-	4	-	-	-	-	
‡**Festuca elatior*	G	PE	-	-	-	-	-	-	-	8v	
Glyceria australis	G	PE	-	-	-	4v	-	-	-	-	
**Hainardia cylindrica*	G	AN	-	-	-	-	-	-	-	-	Cfv
†*Heteropogon contortus*	G	PE	-	-	-	-	-	6v	-	-	
**Holcus lanatus*	G	PE	-	2	-	4	-	-	-	-	
‡*Homopholis* sp. (unnamed)	G	PE	1v	-	-	-	-	-	-	-	
**Hordeum distichon*	G	AN	-	-	3	4	-	-	-	-	Bcv
**Hordeum leporinum*	G	AN	1	2	3	4	5	6v	7	8	
**Hyparrhenia hirta*	G	PE	1	2v	3	4	5	6v	7	8	
Imperata cylindrica var. *major*	G	PE	1	2v	-	4	5	-	-	8	
**Lamarckia aurea*	G	AN	-	-	-	4	5	6v	-	-	
Leptochloa ciliolata	G	PE	-	2v	-	4	-	6v	-	-	
Leptochloa digitata	G	PE	-	-	-	-	-	-	-	-	Bev
**Lolium perenne*	G	SP	1	2	3	4	-	6	7	8	
**Lolium perenne* × *L. multiflorum*	G	SP	-	-	-	-	-	-	-	-	Dfv

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
**Lolium rigidum*	G	AN	1	2	3	4	5	6v	7	8	
**Melinis repens*	G	SP	1	-	-	-	-	-	-	-	Bbv
Microlaena stipoide var. *stipoides*	G	PE	1	2	3	4	5	6v	-	8	
‡**Nassella neesiana*	G	PE	-	-	-	-	-	-	-	-	Efv
Oplismenus aemulus	G	PE	-	2v	-	4	-	-	-	-	
Panicum buncei	G	PE	-	-	-	-	-	-	7v	-	
Panicum decompositum	G	PE	-	-	3	-	-	6v	-	8	
Panicum effusum	G	PE	1	2v	-	4	5	6v	-	8	
Panicum laevinode	G	PE	-	-	-	-	-	-	7v	-	
**Panicum miliaceum*	G	AN	-	-	-	-	-	-	-	-	Cev
Panicum queenslandicum var. *queenslandicum*	G	PE	1v	-	-	-	-	-	-	-	
**Parapholis incurva*	G	AN	-	-	-	-	-	-	-	-	Cfv
Paspalidium aversum	G	PE	-	2v	-	-	5	6v	7	8	
Paspalidium gracile	G	PE	1	2	3	4	-	6v	-	8	
Paspalidium sp. aff. *constrictum*	G	PE	-	2	-	-	-	-	-	-	
**Paspalum dilatatum*	G	PE	1	2	3	4	5	6v	7	8	
Paspalum distichum	G	PE	1	2v	-	4	-	-	-	8	
Pennisetum alopecuroides	G	PE	1	-	-	4	-	-	-	8	Efv
**Pennisetum clandestinum*	G	PE	1	-	3	4	-	6v	-	8	
‡**Pennisetum setaceum*	G	PE	1	-	-	-	-	-	-	-	Ccv
**Pennisetum villosum*	G	PE	-	-	-	-	-	6v	7	-	
Perotis rara	G	AN	-	2v	-	-	-	-	-	-	
**Phalaris aquatica*	G	PE	1	-	3	4	-	-	-	8	
**Phalaris paradoxa*	G	AN	-	-	-	-	-	-	7v	-	
Phragmites australis	G	PE	-	2v	-	-	-	-	-	-	
**Poa annua*	G	AN	1	2v	3	4	5	6v	7	8	
‡**Poa bulbosa*	G	AN	-	-	-	-	-	-	-	-	Ehv
Poa labillardieri	G	PE	-	2v	3	4	5v	6v	-	8	
Poa sieberiana var. *hirtella*	G	PE	-	2v	-	-	-	-	7v	-	
‡*Poa sieberiana* var. *sieberiana*	G	PE	1v	-	-	-	-	-	-	-	
**Polypogon monspeliensis*	G	AN	1	-	-	4	-	-	7	8	Ehv
**Rostraria cristata*	G	AN	1	2	3	4	5	6v	7	8	
‡**Schismus barbatus*	G	AN	-	2v	-	-	-	-	-	-	
**Setaria gracilis*	G	PE	1v	2v	3	4	5	-	-	8	
**Setaria pumila*	G	AN	1	-	-	-	-	-	-	8v	
‡**Setaria verticillata*	G	AN	-	-	-	-	-	-	-	-	Egv
**Sorghum bicolor* subsp. *bicolor*	G	SP	-	-	-	-	-	-	7	-	
**Sorghum halepense*	G	PE	-	-	3	4	5	6v	7	8	
Sorghum leiocladum	G	PE	1	2	3	4	5	6v	-	8	
Sporobolus caroli	G	SP	-	-	-	-	-	6	-	-	
Sporobolus creber	G	PE	1	2	3	4	5	6v	-	8	
‡**Sporobolus indicus* var. *capensis*	G	PE	-	2v	-	-	-	-	-	-	
Themeda australis	G	PE	1	2v	3	4	5	6v	7	8	
Themeda avenacea	G	PE	-	-	-	-	-	-	7v	-	
Tragus australianus	G	AN	1	2	3	4	5	6v	-	-	
Triodia scariosa	G	PE	1v	2v	-	-	-	-	-	-	
Tripogon loliiformis	G	SP	-	2v	3	4v	5	-	-	-	
**Triticum aestivum*	G	AN	-	-	3	-	-	6v	7	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
**Urochloa fasciculata* var. *reticulata*	G	AN	-	-	-	-	-	-	-	-	Cev
Urochloa foliosa	G	PE	1v	2v	-	-	-	-	-	-	
**Urochloa panicoides*	G	AN	-	-	3	-	-	6v	7	8	
Urochloa piligera	G	AN	-	-	-	-	5v	-	-	-	
‡*Vetiveria filipes*	G	PE	-	2v	-	-	-	-	-	-	
**Vulpia bromoides*	G	AN	-	2	-	-	5v	6	-	-	
**Vulpia muralis*	G	AN	-	2	3	4	5v	6	-	8	
**Vulpia myuros*	G	AN	1	2	3	4	5v	6v	7	8	
POTAMOGETONACEAE											
Potamogeton perfoliatus	F	PE	-	2v	-	-	-	-	-	-	
Potamogeton tricarinatus	F	PE	-	2v	-	-	-	-	-	-	
TYPHACEAE											
Typha domingensis	GL	PE	-	-	-	4	-	6v	-	-	
Typha orientalis	GL	PE	-	2v	-	4	-	-	-	8	
XANTHORRHOEACEAE											
Xanthorrhoea glauca subsp. *angustifolia*	TS	PE	1	2	3	4	-	6v	-	-	
DICOTYLEDONS											
ACANTHACEAE											
Brunoniella australis	F	PE	1	-	3	4	-	6v	7	-	
Rostellularia adscendens subsp. *adscendens*	F	PE	1	2	3	4	-	6v	7	8	
AIZOACEAE											
‡**Galenia pubescens*	F	PE	-	-	-	-	-	-	-	-	Dfv
Glinus lotoides	F	AN	-	-	-	-	-	-	-	8v	
‡*Glinus oppositifolius*	F	AN	-	-	-	-	-	-	-	8v	
Tetragonia tetragonoides	F	AN	-	-	-	-	-	-	-	-	Dfv
Zaleya galericulata subsp. *australis*	F	SP	-	-	-	-	-	-	-	-	Ccv
AMARANTHACEAE											
Alternanthera denticulata	F	AN	1	2v	3	4v	-	-	-	8v	
Alternanthera nana	F	AN	-	-	-	-	5v	6	-	8v	
**Alternanthera pungens*	F	SP	1	2	3	4	5	6v	7	8	
Alternanthera sp. A	F	PE	-	-	-	-	-	-	-	-	Efv
Amaranthus macrocarpus var. *macrocarpus*	F	AN	-	2	-	-	-	6	7	-	Dfv
**Amaranthus retroflexus*	F	AN	1	-	3	4	5	6v	7	8	
**Amaranthus viridis*	F	AN	-	-	-	-	-	6v	-	-	
**Gomphrena celosioides*	F	AN	1	-	3	4	5	6v	-	8	
**Guilleminea densa*	F	AN	-	-	-	-	-	-	-	-	Dfv
Nyssanthes diffusa	F	SP	-	2v	-	-	-	-	-	8	
AMYGDALACEAE											
‡**Prunus armeniaca*	T	PE	-	-	-	-	-	6	-	-	
**Prunus cerasifera*	T	PE	-	-	-	-	-	6v	-	8	
**Prunus persica* var. *persica*	T	PE	1v	2	-	4	-	6v	-	-	
ANACARDIACEAE											
**Pistacia chinensis*	T	PE	-	-	-	-	-	6v	-	-	
**Schinus areira*	T	PE	1	2	3	4	5	6v	7	8	
APIACEAE											
**Ammi majus*	F	SP	1	2	3	-	-	6v	7	8	
**Berula erecta*	F	PE	-	-	-	-	-	-	-	-	Efv

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
**Ciclospermum leptophyllum*	F	AN	1	2	3	4	5	6	7v	8	
**Conium maculatum*	F	SP	-	2v	-	-	-	-	-	8	
Daucus glochidiatus form C	F	AN	-	-	-	-	-	-	7v	-	
Daucus glochidiatus form F	F	AN	1	2v	3	4	5	6v	-	8	
**Foeniculum vulgare*	F	SP	-	2	3	-	5	6v	-	8	
Hydrocotyle laxiflora	F	PE	1	-	3	4	5	6v	-	8	
Hydrocotyle tripartita	F	PE	1v	2v	-	4v	-	-	-	-	
**Torilis nodosa*	F	AN	-	-	3v	4	-	-	-	-	
Trachymene incisa	F	PE	-	2v	-	-	-	-	-	-	
APOCYNACEAE											
Alstonia constricta (narrow-leaved pubescent form)	TS	PE	-	-	-	-	-	-	-	-	Dcv
Alstonia constricta (type form)	TS	PE	-	-	-	-	-	-	-	-	Dfv
**Mandevilla laxa*	C	PE	-	-	-	-	-	6v	-	-	
**Nerium oleander*	TS	PE	-	-	-	-	-	6v	-	-	
Parsonsia eucalyptophylla	C	PE	-	-	-	-	-	6	-	-	
Parsonsia lanceolata	C	PE	-	2	3v	-	-	6v	-	-	
**Vinca major*	F	PE	-	-	-	-	-	6	-	-	Egv
ARALIACEAE											
**Hedera helix*	C	PE	-	-	-	-	-	6v	-	-	
ASCLEPIADACEAE											
**Araujia sericifera*	C	PE	-	-	-	-	-	6v	-	-	
**Gomphocarpus fruticosus*	F	PE	1	2	3	4	5	6v	7	8	
Marsdenia pleiadenia (=*Gymnema pleiadenium*)	C	PE	-	-	-	-	-	6v	-	-	
‡*Marsdenia rostrata*	C	PE	-	-	-	-	-	-	-	-	Ehv
Marsdenia viridiflora	C	PE	-	-	-	4v	-	-	-	-	
Sarcostemma viminale subsp. *brunnonianum*	F	PE	-	2	-	4	-	-	-	-	
**Tweedia coerulea*	F	PE	-	-	-	-	-	6v	-	8	
ASTERACEAE											
Actinobole uliginosum	F	AN	-	2v	-	-	-	-	-	-	
Ammobium alatum	F	SP	1	2v	-	-	-	-	-	-	
‡**Anthemis cotula*	F	AN	-	-	-	-	-	-	-	-	Eiv
**Arctotheca calendula*	F	AN	-	2	3	-	5	6v	-	8	
‡**Artemisia ludoviciana*	F	PE	-	-	-	-	-	6v	-	-	
**Aster subulatus*	F	SP	1	2	-	4	5	6v	7	8	
**Bidens pilosa*	F	AN	1	2	3	4	5	6v	7	8	
**Bidens subalternans*	F	AN	1	2v	3	4v	5	6v	7	8	
Brachyscome angustifolia var. *heterophylla*	F	PE	1v	2v	-	4	-	-	-	8	
Brachyscome ciliaris var. *lanuginosa*	F	PE	-	-	-	-	-	-	-	-	Cev
Brachyscome ciliaris var. *subintegrifolia*	F	PE	-	-	-	-	-	-	-	-	Dfv
Brachyscome curvicarpa	F	AN	-	-	-	-	-	-	-	-	Cfv
Brachyscome gracilis	F	AN	-	2v	-	-	-	-	-	-	
Brachyscome multifida var. *multifida*	F	AN	1v	2v	-	-	-	-	-	-	
Brachyscome nova-anglica	F	AN	1v	-	-	4v	-	-	-	-	
Brachyscome procumbens	F	PE	-	-	-	-	-	-	-	-	Dev
‡*Brachyscome rigidula* s. lat.	F	PE	-	-	-	-	-	-	-	-	Ehv
‡*Brachyscome* sp. A	F	AN	-	-	-	-	-	-	-	-	Eev

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Bracteantha bracteata	F	AN	-	2v	-	4	-	6	-	-	
**Calendula officinalis*	F	AN	-	-	-	-	-	6v	-	-	
Calotis cuneifolia	F	PE	-	2v	-	-	-	-	-	-	
Calotis hispidula	F	AN	-	-	-	-	-	-	-	-	Bdv
Calotis lappulacea	F	PE	1	2	3	4	5	6v	-	8	
Calotis scabiosifolia var. *scabiosifolia*	F	PE	-	-	-	-	-	-	7v	-	
**Carduus tenuiflorus*	F	AN	1	2	3	4	5	6v	-	8v	
**Carthamus lanatus*	F	AN	1	2	3	4	5	6v	7	8	
Cassinia arcuata	LS	PE	-	-	-	4v	-	-	-	-	
Cassinia laevis	LS	PE	1	2v	3	4	-	-	-	-	
Cassinia quinquefaria	LS	PE	-	2	-	-	5	6v	-	8v	
Cassinia uncata	LS	PE	-	2v	-	-	-	-	-	-	
Cassinia sp. B (aff. *leptocephala*)	LS	PE	-	-	-	4v	-	-	-	-	
**Centaurea calcitrapa*	F	SP	1	-	-	4	-	6	-	8v	
**Centaurea melitensis*	F	AN	1	2	3	4	5	6v	7	8	
**Centaurea solstitialis*	F	SP	1	-	3	4	5	6v	7	8	
Centipeda minima	F	AN	1	2v	-	-	-	-	-	8	
**Chondrilla juncea*	F	PE	1	2	3	4	5	6	7	8	
Chrysocephalum apiculatum s. lat.	F	PE	1	2v	3	4	5	6v	7	8	
Chrysocephalum semipapposum s. lat.	F	PE	-	-	-	-	-	-	-	-	Cev
**Cichorium intybus*	F	PE	-	-	3	-	-	-	7	-	Dfv
**Cirsium vulgare*	F	SP	1	2	3	4	5	6v	7	8	
**Conyza albida*	F	AN	1	2	3	4	5	6v	7	8	
**Conyza bonariensis*	F	AN	1	2v	3	4	5	6v	7	8	
‡**Conyza parva*	F	AN	-	2v	3v	4v	5v	-	-	-	
**Coreopsis lanceolata*	F	PE	-	-	-	-	-	-	-	-	Dfv
**Cosmos bipinnatus*	F	AN	-	-	-	-	-	-	-	-	Dfv
Cotula australis	F	SP	1	2	-	4	5v	6v	-	8	
**Crepis capillaris*	F	SP	-	2v	-	-	-	6	-	8v	
Cymbonotus lawsonianus	F	PE	1	2	3	4v	5	6v	7	8	
**Dimorphotheca pluvialis*	F	AN	-	-	-	-	-	6v	-	-	
**Dittrichia graveolens*	F	AN	1v	2	-	4	-	-	-	8	
Eclipta platyglossa	F	AN	1v	-	-	-	-	-	-	-	
Euchiton gymnocephalus (= *Gnaphalium gymnocephalum*)	F	PE	1	2v	-	4v	-	6v	-	8	
Euchiton involucratus (= *Gnaphalium involucratum*)	F	PE	1	2	-	4v	5	6v	7	8	
Euchiton sphaericus (= *Gnaphalium sphaericum*)	F	SP	1	2v	3	4v	5	6v	-	-	
**Gamochaeta calviceps* (= *Gnaphalium calviceps*)	F	AN	1	2v	-	-	-	-	-	-	
**Gamochaeta purpurea* (= *Gnaphalium coarctatum*)	F	SP	1v	2v	-	4	5	6	-	-	
Glossogyne tannensis	F	PE	1	2	3	4	5	6v	-	8	
‡**Gnaphalium polycaulon*	F	AN	-	2v	-	-	-	-	-	-	
**Hedypnois rhagadioloides* subsp. *cretica*	F	AN	-	-	3	-	5	6v	7	8	
**Helianthus annuus*	F	SP	-	-	3v	-	-	6v	-	-	
**Hypochaeris glabra*	F	AN	1	2	3	4v	5	6v	7	8	
**Hypochaeris microcephala* var. *albiflora*	F	PE	1v	2v	-	-	-	-	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
**Hypochaeris radicata*	F	PE	1	2	3	4v	5	6	-	8	
Isoetopsis graminifolia	GL	AN	-	-	-	4v	-	6v	-	-	
Ixiolaena tomentosa	F	PE	-	-	-	-	-	-	7v	-	
**Lactuca saligna*	F	SP	1	2	3	4	-	6v	7	8	
**Lactuca serriola*	F	SP	1	2	3	4	5	6v	7	8	
Lagenifera stipitata	F	PE	-	2	-	4v	5	6v	-	8	
‡**Lapsana communis* subsp. *communis*	F	AN	-	2v	-	-	-	-	-	-	
Leptorhynchos panaetioides	F	PE	-	-	-	-	-	6v	7v	-	
Leptorhynchos squamatus subsp. A	F	PE	-	-	-	-	-	6v	-	-	
Leucochrysum albicans subsp. *albicans* var. *albicans*	F	PE	1v	-	-	-	-	-	-	-	
Microseris lanceolata (rhizomatous form)	F	PA	-	-	-	-	-	-	7v	-	
Microseris lanceolata (tuberous form)	F	PA	1v	-	-	-	-	-	-	8	
Minuria cunninghamii s. lat.	F	PE	1v	-	-	-	-	-	-	-	Ehv
Minuria leptophylla	F	PE	-	-	-	-	-	-	-	-	Ehv
Olearia elliptica	LS	PE	1	2	3	4	-	6v	7	8	
Olearia ramosissima	LS	PE	-	2v	-	-	-	-	-	-	
Olearia viscidula	LS	PE	1v	2	-	4	-	6v	-	8	
**Onopordum illyricum* subsp. *illyricum*	F	PE	-	-	-	-	-	-	-	-	Eiv
‡*Ozothamnus ferrugineus* s. lat.	TS	PE	-	-	-	-	-	-	-	-	Eiv
Ozothamnus obcordatus subsp. *major*	LS	PE	-	2v	-	-	-	-	-	-	
‡*Picris angustifolia* subsp. *carolorum-henricorum*	F	AN	-	-	-	4v	-	6v	-	-	
‡*Picris eichleri*	F	AN	1v	-	-	-	-	-	-	-	
Podolepis jaceoides	F	PE	-	2v	-	-	-	-	-	-	
Podolepis neglecta	F	PE	-	-	-	4v	-	-	-	-	
Pseudognaphalium luteoalbum	F	AN	1	2v	-	4	-	-	-	8v	
Pycnosorus globosus	F	PE	-	-	-	-	-	-	7v	-	
Rhodanthe anthemoides	F	PE	-	-	-	4v	-	-	-	-	
**Schkuhria pinnata* var. *abrotanoides*	F	AN	-	-	3	4	5	6v	7	8	
Senecio diaschides	F	PE	1v	2v	-	-	-	-	-	-	
Senecio hispidulus var. *dissectus*	F	PE	1	2v	-	4	5	6v	-	8	
Senecio hispidulus var. *hispidulus*	F	PE	1	2v	-	4v	5	-	-	-	
Senecio lautus subsp. *dissectifolius*	F	PE	1v	2	-	4v	-	6v	-	-	
‡**Senecio madagascariensis*	F	SP	-	-	-	-	-	-	-	-	Dfv
Senecio quadridentatus	F	PE	1	2	3	4	-	6v	7	8	
‡*Senecio* sp. E	F	PE	1v	-	-	-	-	-	-	-	
Sigesbeckia australiensis	F	AN	1	2	3	4	5	6v	-	8	
**Silybum marianum*	F	SP	1	2	3	4	5	6v	7v	8	
Solenogyne bellioides	F	PE	-	2v	-	4	-	-	-	-	
**Soliva anthemifolia*	F	AN	-	2v	-	-	-	-	-	-	
**Soliva sessilis*	F	AN	1	2	-	4v	-	6v	-	8	
**Soliva stolonifera*	F	AN	-	-	-	4v	-	6	-	-	
‡**Sonchus asper*	F	AN	-	-	-	-	-	-	-	-	Efv

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
**Sonchus oleraceus* subsp. *glaucescens*	F	AN	1	2	3	4	5	6v	7	8	
Stuartina hamata	F	AN	-	2v	-	4v	5	6v	-	8v	
Stuartina muelleri	F	AN	-	-	-	4v	-	-	-	-	
**Tagetes minuta*	F	AN	1	2	-	4	-	6v	-	8	
**Taraxacum officinale*	F	PE	1	-	-	4	-	6v	-	8	
**Tolpis umbellata*	F	AN	-	2v	-	4v	5	-	-	8	
**Tragopogon porrifolius*	F	SP	-	-	3	-	-	6v	7	8	
Triptilodiscus pygmaeus	F	AN	-	2	-	4v	5	6v	-	-	
**Verbesina encelioides* subsp. *encelioides*	F	AN	-	2	-	-	-	-	-	-	Ccv
Vittadinia muelleri	F	PE	1	2v	3	4	5	6v	-	8	
Vittadinia sulcata	F	AN	1	2	3	4	-	6v	7	8	
**Xanthium occidentale*	F	AN	1	2	-	4	-	6v	-	8	
**Xanthium spinosum*	F	AN	1	2	3	-	5	6	7	8	
**Zinnia peruviana*	F	AN	1	2v	-	-	-	-	-	-	
BASELLACEAE											
**Anredera cordifolia*	C	PA	-	-	3	-	-	-	-	-	Dfv
BERBERIDACEAE											
**Nandina domestica*	LS	PE	-	-	-	-	-	6v	-	8	
BIGNONIACEAE											
**Jacaranda mimosifolia*	T	PE	-	-	-	-	-	6v	-	-	
**Macfadyena unguis-cati*	C	PE	-	-	-	-	-	6v	-	-	
Pandorea pandorana	C	PE	-	2	3	4	-	6v	-	8	
BORAGINACEAE											
**Amsinckia calycina*	F	AN	-	-	-	4v	-	6v	-	-	
‡*Austrocynoglossum latifolium*	F	PE	-	-	-	-	-	-	-	-	Ehv
**Buglossoides arvensis*	F	AN	-	-	3	4	-	6v	7v	-	
Cynoglossum australe	F	PE	1v	2	-	4	5	6	-	8v	
Cynoglossum suaveolens	F	PE	-	-	-	-	-	6v	-	-	
**Echium plantagineum*	F	AN	1	2	3	4	5	6v	-	8	
**Heliotropium amplexicaule*	F	PE	-	2	-	-	5	6v	-	8	
Myosotis australis	F	SP	-	2v	-	-	-	-	-	-	
**Myosotis discolor*	F	AN	-	2v	-	-	5v	-	-	-	
Plagiobothrys plurisepaleus	F	AN	-	-	-	-	-	-	-	-	Efv
BRASSICACEAE											
**Capsella bursa-pastoris*	F	AN	1	2	3	4	5	6v	7	8	
Cardamine papillata (previously part of *C. paucijuga*)	F	AN	1v	2v	-	4v	-	-	-	-	
**Coronopus didymus*	F	SP	-	-	-	-	-	6v	-	-	
**Hirschfeldia incana*	F	SP	1	2	3	4	5	6v	-	8	
**Lepidium africanum*	F	SP	1	2	3	4	5	6v	7v	8	
**Lepidium bonariense*	F	SP	1	2v	-	4	-	6v	-	8	
Lepidium fasciculatum	F	AN	-	-	-	-	-	-	-	-	Cev
‡*Lepidium pseudohyssopifolium*	F	SP	1v	-	-	-	-	-	-	-	
**Raphanus raphanistrum*	F	SP	-	-	-	4	-	-	-	-	Dfv
**Rapistrum rugosum*	F	SP	-	-	3	4	-	6v	7	-	
Rorippa eustylis	F	AN	-	2v	-	-	-	-	-	-	
Rorippa laciniata	F	PE	-	2v	-	-	-	-	-	-	8v
**Rorippa nasturtium-aquaticum*	F	PE	-	-	-	4	-	-	-	8	Ehv
**Rorippa palustris*	F	SP	-	2v	-	-	-	-	-	-	
**Sisymbrium irio*	F	SP	-	-	3	-	-	6	7v	-	
**Sisymbrium officinale*	F	SP	1	2	3	4	5	6v	-	8	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
**Sisymbrium orientale*	F	SP	-	-	3v	4	-	6v	7	8	
CACTACEAE											
**Opuntia aurantiaca*	F	PE	-	-	3	4	5	6	-	-	
**Opuntia imbricata*	LS	PE	-	-	-	-	-	-	-	-	Df
**Opuntia stricta* var. *stricta*	LS	PE	1	2	3	4	5	6	7	8	
‡**Opuntia vulgaris*	TS	PE	-	-	-	-	-	6	-	-	
CALLITRICHACEAE											
‡**Callitriche stagnalis*	F	AN	-	2v	-	-	-	-	-	-	
CAMPANULACEAE											
Wahlenbergia communis	F	PE	1v	2v	3	-	5v	-	7v	-	
Wahlenbergia gracilis	F	PE	-	2v	-	4v	-	6v	-	8	
Wahlenbergia luteola	F	PE	-	-	-	-	-	-	7v	-	
Wahlenbergia planiflora subsp. *longipila*	F	PE	-	2v	3	4v	5v	6v	-	8	
Wahlenbergia stricta subsp. *stricta*	F	PE	1v	2	-	-	-	6v	-	8	
CAPPARIDACEAE											
Capparis mitchellii	T	PE	-	-	-	-	-	6	-	-	Dfv
CAPRIFOLIACEAE											
‡**Lonicera fragrantissima*	LS	PE	-	-	-	-	-	-	-	-	Bev
**Lonicera japonica*	C	PE	-	-	-	-	-	-	-	-	Dfv
CARYOPHYLLACEAE											
**Arenaria leptoclados*	F	AN	1	2	3v	4	5v	6	-	8	
**Cerastium fontanum* subsp. *vulgare*	F	PE	-	-	-	-	-	-	-	-	Ehv
**Cerastium glomeratum*	F	AN	1	2	-	4	5	6v	-	8	
**Gypsophila tubulosa*	F	AN	1v	2	-	4v	-	-	-	-	
**Moenchia erecta*	F	AN	-	2v	-	-	-	-	-	-	
**Paronychia brasiliana*	F	PE	1	2	-	4	5	6v	-	8	
**Petrorhagia nanteuilii*	F	AN	1	2	3	4v	5	6v	-	8	
**Polycarpon tetraphyllum*	F	AN	1v	2v	-	4	5	6v	-	8	
‡**Sagina apetala*	F	AN	1	2	-	4v	-	6	-	8v	
Scleranthus biflorus	F	PE	-	-	-	-	-	-	-	-	Ehv
Scleranthus diander	F	PE	1v	-	-	-	-	-	-	-	
**Silene gallica* var. *gallica*	F	AN	-	2v	-	-	-	-	-	-	
‡**Silene gallica* var. *quinquevulnera*	F	AN	-	-	-	4v	-	-	-	-	
‡**Silene nocturna*	F	AN	1v	-	-	-	-	-	-	-	
**Spergularia rubra*	F	SP	1v	-	-	-	5	-	-	8	
Stellaria angustifolia	F	PE	1v	2v	-	4v	5	6	-	-	
**Stellaria media*	F	SP	1	2	3	4	5	6v	-	8	
‡**Stellaria pallida*	F	AN	1	2	-	-	5v	-	-	-	
Stellaria pungens	F	PE	-	2v	-	-	-	-	-	8	
CASUARINACEAE											
Casuarina cunninghamiana subsp. *cunninghamia*	T	PE	1	2v	-	4	-	-	-	8	
CELASTRACEAE											
‡*Celastrus australis*	C	PE	-	-	-	-	-	-	-	-	Dev
Maytenus cunninghamii	TS	PE	-	-	-	4	-	6v	-	-	
CHENOPODIACEAE											
Atriplex semibaccata	F	PE	1v	-	3	4v	-	6v	-	8	
**Chenopodium album*	F	AN	-	-	3	-	5	6v	-	8	
**Chenopodium ambrosioides*	F	PE	1	2v	-	-	5	6v	-	8	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Chenopodium pumilio	F	AN	1	2	3	4	5	6v	-	8	
Einadia hastata	F	PE	1	2v	-	-	5	-	-	8	
Einadia nutans subsp. *nutans*	F	PE	1v	2v	-	4	5	6v	7	8	
Einadia trigonos subsp. *stellulata*	F	PE	1	2	3	4	5	6v	-	8	
‡*Maireana enchylaenoides*	F	PE	1v	-	-	-	-	-	-	-	
Maireana microphylla	LS	PE	1	-	3	-	-	6v	-	8	
†*Rhagodia parabolica*	LS	PE	-	-	-	-	-	6v	-	-	
Salsola kali var. *kali*	F	SP	1	2	3	4	-	6v	-	8	
Scleroblitum atriplicinum	F	AN	-	-	-	-	-	-	-	-	Bdv
Sclerolaena birchii	F	PE	-	-	-	-	-	-	-	-	Bdv
Sclerolaena muricata var. *villosa*	F	PE	-	-	-	-	-	-	7v	-	
CHLOANTHACEAE											
Spartothamnella juncea	LS	PE	-	2v	-	-	-	-	-	-	
CLUSIACEAE											
Hypericum gramineum	F	PE	1	2	3	4	5	6v	-	8	
Hypericum japonicum	F	PE	-	2v	-	-	-	-	-	-	
**Hypericum perforatum*	F	PE	-	-	-	-	-	-	-	-	Efv
CONVOLVULACEAE											
**Convolvulus arvensis*	C	PE	-	-	-	-	-	-	-	-	Dfv
Convolvulus erubescens	C	PE	1	-	3	-	-	6v	7	8v	
Cuscuta australis	P	PE	-	2v	-	-	-	-	-	-	
**Cuscuta campestris*	P	PE	-	-	-	-	-	-	-	-	Bcv
Dichondra repens	F	PE	1	2	3	4	5	6v	7	8	
Evolvulus alsinoides var. *decumbens*	F	PE	-	2	-	4	-	6v	-	-	
**Ipomoea cairica*	C	PE	-	-	-	-	-	6v	-	-	
**Ipomoea indica*	C	PE	-	-	-	-	-	6	-	-	Dfv
CRASSULACEAE											
**Bryophyllum daigremontianum* × *B. tubiflorum*	F	PE	-	-	-	-	-	6v	-	-	
‡*Crassula decumbens* var. *decumbens*	F	AN	-	2v	-	-	-	-	-	-	
Crassula peduncularis	F	AN	-	2v	-	4v	-	-	-	-	
Crassula sieberiana	F	SP	1	2	3	4v	5	6v	7	8	
**Sedum dendroideum*	F	PE	-	-	-	-	-	6v	-	-	
CUCURBITACEAE											
**Citrullus lanatus* var. *lanatus*	F	AN	1	2v	-	-	5	-	-	8v	
**Cucumis myriocarpus*	F	AN	-	2	-	-	5	-	7	8v	
CUNONIACEAE											
‡*Aphanopetalum resinosum*	C	PE	-	-	-	-	-	-	-	-	Ehv
DILLENIACEAE											
Hibbertia acicularis	LS	PE	-	-	-	-	-	6v	-	8	
Hibbertia obtusifolia	LS	PE	1	2	-	4v	5	6v	-	8	
DROSERACEAE											
Drosera auriculata	F	AN	-	2	-	4v	5	-	-	-	
ELATINACEAE											
Elatine gratioloides	F	AN	-	2	-	-	-	-	-	8v	
EPACRIDACEAE											
Brachyloma daphnoides subsp. *glabrum*	LS	PE	-	2v	-	-	-	-	-	-	
Leucopogon muticus	LS	PE	-	2v	-	-	-	-	-	-	

Species	Life form	Life cycle	Site								Other
			1	2	3	4	5	6	7	8	
Lissanthe strigosa subsp. *subulata*	LS	PE	1v	-	-	-	-	-	-	-	
Melichrus urceolatus	LS	PE	1	2v	-	4v	5	6v	-	8	
EUPHORBIACEAE											
Adriana tomentosa var. *tomentosa* (=*A. glabrata* var. *subglabra*)	LS	PE	1	-	3	-	-	-	-	8	Dfv
‡*Bertya cunninghamii*	LS	PE	-	-	-	-	-	-	-	-	Efv
Beyeria viscosa	LS	PE	-	2v	3v	4v	-	-	-	-	
Breynia oblongifolia	LS	PE	-	2	-	4	-	6v	-	-	
Chamaesyce dallachyana	F	PE	1v	-	-	-	-	-	-	-	
Chamaesyce drummondii	F	PE	1	2v	3	4v	5	6	7	8	
‡**Chamaesyce prostrata*	F	AN	-	-	-	-	-	-	-	-	Cev
Chamaesyce sp. A	F	PE	-	-	-	-	-	-	-	8v	
Croton phebalioides	LS	PE	-	-	-	-	-	6v	-	-	
**Euphorbia davidii*	F	AN	-	-	-	-	-	-	-	-	Dfv
Euphorbia eremophila	F	SP	-	2	-	4	-	6v	-	-	
**Euphorbia lathyrus*	F	SP	1	-	-	-	-	-	-	8	Ehv
**Euphorbia peplus*	F	AN	1	2	-	-	-	6v	-	8	
Phyllanthus gunnii	LS	PE	1	2v	-	-	-	-	-	-	
Phyllanthus hebecarpus	LS	PE	-	2v	-	-	-	-	-	-	
Phyllanthus subcrenulatus	LS	PE	-	2v	-	4	-	6v	-	-	
Phyllanthus virgatus complex	F	SP	1	2v	-	4v	5	6v	-	8	
Poranthera microphylla	F	AN	1	2	-	4	-	6v	-	8	
FABACEAE											
†*Acacia baileyana*	T	PE	-	-	-	-	-	-	-	-	Cdv
Acacia brownii	LS	PE	-	-	-	-	-	-	-	8v	
Acacia cheelii	TS	PE	-	2	-	-	-	-	-	-	Efv
†*Acacia cultriformis*	TS	PE	-	-	-	-	-	-	-	-	Efv
Acacia dealbata	T	PE	-	-	-	-	-	-	-	-	Eiv
Acacia deanei subsp. *deanei*	TS	PE	-	-	-	4	-	6v	-	-	
Acacia decora	LS	PE	1v	2	-	4v	-	6v	7	-	
**Acacia farnesiana*	LS	PE	-	-	3	-	-	6	-	-	Dev
Acacia homalophylla	TS	PE	-	-	-	-	-	-	-	-	Dev
Acacia implexa	T	PE	1	2	3	4v	-	6v	7	8	
Acacia leptoclada	TS	PE	1v	-	-	-	-	-	-	-	
Acacia leucoclada subsp. *leucoclada*	TS	PE	1v	-	-	4v	-	-	-	-	
Acacia melanoxylon	T	PE	-	-	-	-	-	-	-	-	Fgv
Acacia montana	TS	PE	-	-	-	4v	-	-	-	-	
Acacia neriifolia	TS	PE	1	2	-	4v	-	6v	-	-	
Acacia paradoxa	TS	PE	1	2	-	-	-	6v	-	-	
Acacia pendula	T	PE	-	-	-	-	-	-	-	-	Bdv
Acacia penninervis	T	PE	-	2v	-	-	-	-	-	-	
Acacia pruinosa	TS	PE	-	2v	-	-	-	-	-	-	
Acacia salicina	TS	PE	-	-	3	4v	-	-	7v	-	
‡†*Acacia vestita*	TS	PE	-	-	-	-	-	-	-	-	Ehv
Acacia viscidula	LS	PE	-	-	-	-	-	-	-	8v	
Crotalaria dissitiflora subsp. *dissitiflora*	F	PE	-	-	-	-	-	-	-	-	Bc
Cullen tenax (= *Psoralea tenax*)	F	PE	-	-	-	-	-	-	7	-	Dfv
Daviesia genistifolia (< 50 cm high)	LS	PE	-	-	-	-	-	-	-	-	Ehv

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Daviesia genistifolia (to 2 m high)	LS	PE	1v	-	-	-	-	-	-	-	
Daviesia latifolia	LS	PE	-	-	-	-	-	-	-	-	Eiv
‡*Daviesia leptophylla*	LS	PE	-	-	-	-	-	-	-	-	Ehv
Daviesia pubigera	LS	PE	1v	-	-	-	-	-	-	-	
Desmodium brachypodum	F	PE	1	2	3	4	5	6v	-	8	
Desmodium varians	F	PE	1	2	3	4	5	6v		8	
Dillwynia sieberi	LS	PE	-	2v	-	-	-	-	-	-	
**Genista monspessulana*	LS	PE	-	-	-	-	-	-	-	-	Ehv
‡**Gleditsia triacanthos*	T	PE	-	-	-	-	-	-	-	-	Dfv
Glycine clandestina var. *sericea*	C	PE	1	2	3	4v	5	6v	-	8	
‡*Glycine clandestina* (serpentinite form)	C	PE	1	-	-	-	-	-	-	-	Ehv
Glycine latifolia	C	PE	-	-	-	-	-	6v	7v	-	
Glycine tabacina	C	PE	1	2v	3v	4v	5v	6v	-	-	
Glycine tomentella s. lat.	C	PE	-	-	3	4	-	6v	-	8	
Hardenbergia violacea	C	PE	1	2	-	4v	5	6v	-	8	
Hovea lanceolata	LS	PE	-	2	-	4v	-	6v	-	-	
Hovea linearis	LS	PE	-	-	-	-	-	-	-	-	Ehv
‡*Hovea* sp.	LS	PE	1v	-	-	-	-	-	-	-	
Indigofera adesmiifolia	LS	PE	-	2	-	4	-	6v	-	-	
Indigofera australis	LS	PE	-	-	-	-	-	-	-	8v	
‡*Indigofera linifolia*	F	PE	-	-	-	-	-	-	-	-	Aev
‡**Lathyrus odoratus*	F	AN	-	-	3	-	-	6v	-	-	
Lespedeza juncea subsp. *sericea*	LS	PE	-	2v	-	-	-	-	-	8v	
Lotus australis	F	PE	1v	-	3	4	-	6v	-	-	
**Macroptilium atropurpureum*	C	AN	-	-	-	-	-	-	-	-	Dgv
**Medicago arabica*	F	AN	1	-	-	4	-	6	-	8v	
**Medicago laciniata*	F	AN	-	-	-	-	-	-	-	-	Bdv
**Medicago lupulina*	F	SP	1	-	3	4	-	6v	-	8v	
**Medicago minima*	F	AN	1	2	3	4	5	6v	7	8	
**Medicago orbicularis*	F	AN	-	-	3	-	-	6v	7	8	
**Medicago polymorpha* var. *vulgaris*	F	AN	1	2	3	4	-	6v	7	8	
**Medicago sativa*	F	PE	1	-	3	-	5	6v	7	8	
‡**Medicago scutellata*	F	AN	-	-	-	-	-	-	-	-	Dfv
**Medicago truncatula*	F	AN	-	2	-	-	-	-	7v	-	
**Melilotus albus*	F	SP	-	-	-	-	-	6v	-	8	
**Melilotus indicus*	F	AN	1	-	3	4	-	6v	7	8	
Mirbelia pungens	LS	PE	-	2v	-	-	-	-	-	-	
Neptunia gracilis	F	PE	-	-	-	-	-	-	7	-	Dfv
Pultenaea foliolosa	LS	PE	1v	2v	-	-	-	-	-	-	
Pultenaea microphylla	LS	PE	-	-	-	-	-	-	-	-	Ehv
Pultenaea sp. G (aff. *microphylla*)	LS	PE	-	2v	-	-	-	-	-	-	
Rhynchosia minima	C	PE	-	-	3	4	-	6v	7	8	
**Robinia pseudoacacia*	T	PE	-	-	-	-	-	-	-	-	Ehv
Senna aciphylla	LS	PE	-	-	-	4v	-	-	-	-	
Senna artemisioides subsp. *zygophylla*	LS	PE	-	-	-	-	-	6v	-	-	
Senna barclayana	F	PE	1	-	3	4	-	6v	7	-	
Senna coronilloides	LS	PE	-	-	-	-	-	6v	-	-	
**Senna pendula* var. *glabrata*	T	PE	-	-	-	-	-	-	-	-	Cgv
Swainsona galegifolia	F	PE	1	-	3	4	-	6v	-	8	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Swainsona monticola	F	PE	-	-	-	-	-	6v	-	-	
Swainsona reticulata	F	PE	-	-	-	4v	5	-	7v	8	
Templetonia stenophylla	LS	PE	1v	-	-	-	-	6v	-	-	
Tephrosia brachyodon	F	PE	1v	-	-	-	-	6v	-	-	
**Trifolium angustifolium*	F	AN	-	-	-	-	-	6v	7	8	
**Trifolium arvense*	F	AN	1	2	3	4	5	6v	7	8	
**Trifolium campestre*	F	AN	1	2	3	4	5	6v	7	8	
**Trifolium cernuum*	F	AN	-	2v	-	4v	5	-	-	8	
**Trifolium dubium*	F	AN	1	2v	-	4	5	-	-	8	
**Trifolium fragiferum*	F	PE	-	-	-	-	-	-	-	-	Dfv
**Trifolium glomeratum*	F	AN	1v	2	3	4	5	6v	7	8	
**Trifolium pratense*	F	PE	-	-	-	-	-	-	-	8	Efv
**Trifolium repens*	F	PE	1	2	3	4	5	6v	7	8	
‡**Trifolium resupinatum*	F	AN	-	-	-	-	-	-	-	-	Cgv
**Trifolium striatum*	F	AN	-	-	-	-	-	-	-	-	Dfv
**Trifolium subterraneum*	F	AN	-	-	-	-	5	-	-	8v	
**Trifolium tomentosum*	F	AN	1v	-	-	-	-	-	7	8v	
**Vicia hirsuta*	C	AN	-	-	-	-	-	-	-	8v	
‡**Vicia monantha* subsp. *triflora*	C	AN	-	-	-	-	-	6v	-	-	
**Vicia sativa* subsp. *angustifolia*	C	AN	1	2v	-	-	-	6	-	8	
**Vicia villosa* subsp. *eriocarpa*	C	AN	-	-	3	-	-	-	7v	-	
Zornia dyctiocarpa var. *dyctiocarpa*	F	PE	-	2v	-	4	-	-	-	-	
FUMARIACEAE											
**Fumaria bastardii*	F	AN	-	2v	-	-	-	-	-	-	
**Fumaria capreolata* subsp. *capreolata*	F	AN	1v	2	3v	4	5	6v	7	8	
**Fumaria densiflora*	F	AN	1	-	3v	4	-	-	-	-	
**Fumaria muralis* subsp. *muralis*	F	AN	1v	-	-	4	-	6v	-	-	
GENTIANACEAE											
**Centaurium erythraea*	F	AN	-	2	-	-	-	6v	-	8	
‡*Centaurium spicatum*	F	AN	-	2v	-	-	-	-	-	-	
**Centaurium tenuiflorum*	F	AN	1	2	3	4	5v	6	-	8v	
GERANIACEAE											
**Erodium cicutarium*	F	AN	1	2	-	4	5	6v	-	8v	
Erodium crinitum	F	AN	1	2	3	4	5	6v	7	8	
**Geranium molle* subsp. *molle*	F	SP	1	2v	3	4	5	6v	-	8	
Geranium solanderi var. *solanderi*	F	PE	1	2	3	4v	5	6v	7	8	
Pelargonium australe	F	PE	-	-	-	-	-	-	-	8v	
**Pelargonium* × *hortorum*	F	PE	-	-	-	-	-	6v	-	-	
GOODENIACEAE											
Goodenia glabra	F	PE	1	-	3	4	5	6v	-	-	
Goodenia hederacea subsp. *hederacea*	F	PE	1v	2	-	4v	-	-	-	8v	
Goodenia pinnatifida	F	AN	1	-	3	4	-	6v	7v	-	
Velleia paradoxa	F	PE	-	-	-	-	-	6v	-	-	
HALORAGACEAE											
‡*Gonocarpus tetragynus*	F	PE	-	-	-	-	-	-	-	8v	
Haloragis glauca forma *glauca*	F	PE	-	-	-	-	-	-	-	-	Dfv
Haloragis heterophylla	F	PE	-	2v	-	4v	5	-	-	8	
Haloragis heterophylla intergrade with *H. aspera*	F	PE	-	-	-	-	-	-	7v	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Haloragis serra	F	PE	-	-	3	4	-	6v	-	-	
‡*Myriophyllum pedunculatum* subsp. *longibracteolatum*	F	PE	-	2v	-	-	-	-	-	-	
Myriophyllum verrucosum	F	PE	1	2v	-	-	-	-	-	8v	
LAMIACEAE											
Ajuga australis s. lat.	F	PE	1v	2	-	4v	5	6v	-	8	
**Lamium amplexicaule*	F	AN	1	2	3	4	5	6	7v	8	
**Marrubium vulgare*	F	PE	1	2	3	4	5	6v	7	8	
Mentha laxiflora	F	PE	-	2v	-	-	-	-	-	-	
Mentha satureioides	F	PE	1	-	-	-	-	6v	7	8	
‡**Mentha* × *spicata*	F	PE	1v	-	-	-	-	-	-	-	
Mentha sp. (aff. *diemenica*)	F	PE	-	-	-	-	-	6v	-	-	
Plectranthus parviflorus	F	PE	-	2v	-	4v	-	6v	-	-	
Prostanthera nivea var. *nivea*	LS	PE	-	2v	-	-	-	-	-	-	
Salvia plebeia	F	PE	1v	-	-	-	-	-	-	-	
**Salvia reflexa*	F	AN	1	-	3	-	-	6v	7	-	
**Salvia verbenaca*	F	PE	1	-	3	-	5	6v	7	8	
Scutellaria humilis	F	PE	1	2	-	4	-	6v	-	8	
**Stachys arvensis*	F	AN	-	2	-	-	-	-	7	8	
Teucrium argutum	F	PE	-	-	-	-	-	-	-	-	Ehv
Teucrium sp. A	F	PE	-	-	-	-	-	-	-	-	Cdv
Teucrium sp. D	F	PE	-	-	-	-	-	-	-	-	Eev
LINACEAE											
Linum marginale	F	PE	1v	-	3	-	-	-	-	-	
LOBELIACEAE											
Isotoma axillaris	F	PE	-	2	-	4	5	-	-	8v	
Isotoma fluviatilis subsp. *borealis*	F	PE	-	2v	-	-	-	-	-	-	
Lobelia gibbosa	F	AN	1v	-	-	-	-	-	-	-	
Pratia concolor	F	PE	-	-	-	-	-	6v	7	-	
Pratia purpurascens	F	PE	1v	-	-	4	-	6v	-	8	
LOGANIACEAE											
Logania albiflora	LS	PE	1v	-	-	-	-	-	-	8	
LORANTHACEAE											
Amyema bifurcatum var. *bifurcatum*	P	PE	1v	-	-	-	-	-	-	-	
Amyema cambagei	P	PE	1	2v	-	-	-	-	-	8	
Amyema miquelii	P	PE	1	2v	3	4	5	6v	-	8	
Amyema miraculosum subsp. *boormanii*	P	PE	1v	-	3v	-	-	-	-	8v	
Amyema quandang var. *quandang* intergrade with var. *bancroftii*	P	PE	-	2v	-	-	-	-	-	-	
Dendrophthoe glabrescens	P	PE	1v	-	-	-	-	-	-	-	
Dendrophthoe vitellina	P	PE	-	-	3	4	-	6v	-	8	
Lysiana subfalcata	P	PE	-	-	-	-	-	6v	-	-	
Muellerina bidwillii	P	PE	-	2v	-	4	-	6v	-	-	
Muellerina eucalyptoides	P	PE	-	2	-	4v	-	-	-	8	
LYTHRACEAE											
‡*Lythrum hyssopifolia*	F	AN	-	-	-	-	-	-	-	8v	
MALACEAE											
**Cotoneaster glaucophyllus*	TS	PE	-	-	-	-	5	6v	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
‡**Cotoneaster pannosus*	TS	PE	-	-	-	-	-	6v	-	-	
‡**Crataegus monogyna*	TS	PE	-	-	-	-	-	-	-	-	Egv
**Malus* × *domestica*	TS	PE	-	-	-	-	-	6v	-	-	
**Photinia serratifolia*	TS	PE	-	-	-	-	-	6v	-	-	
**Pyracantha angustifolia*	TS	PE	-	-	-	-	-	6v	-	-	
**Pyracantha crenulata*	TS	PE	-	-	-	-	-	6v	-	-	
‡**Pyracantha fortuneana* TS	PE		-	-	-	-	-	6v	-	-	
‡**Pyracantha rogersiana* TS	PE		-	-	-	-	-	-	-	8	Ehv
‡**Spiraea cantoniensis* var. *lanceolata*	LS	PE	-	-	-	-	-	-	-	-	Eh
MALVACEAE											
Abutilon oxycarpum var. *oxycarpum*	LS	PE	-	2	-	-	-	6v	-	-	
Abutilon tubulosum	LS	PE	-	2	-	-	-	6v	-	-	
Hibiscus sturtii var. *sturtii*	LS	PE	-	-	-	4	-	6v	-	-	
**Hibiscus trionum* var. *trionum*	F	SP	-	-	-	-	-	-	-	-	Dfv
‡**Malva parviflora*	F	AN	1	-	3	4	-	6	7v	8	
**Malvastrum americanum*	F	SP	-	-	3	-	-	6v	-	-	
**Modiola caroliniana*	F	SP	1	2	-	4	-	6v	7	8	
**Pavonia hastata*	LS	PE	1	2v	-	-	5v	-	-	8	
‡*Sida atherophora*	LS	PE	-	-	-	-	5v	-	-	-	
Sida corrugata	F	PE	1	-	3	4	5	6v	7	8	
Sida cunninghamii	F	PE	-	-	3	4	-	6v	-	-	
**Sida rhombifolia*	LS	PE	-	-	-	4	5v	6	-	-	
**Sida spinosa*	LS	PE	-	-	3v	-	-	-	-	-	
Sida subspicata	LS	PE	-	2v	-	-	-	-	-	-	
Sida trichopoda	F	PE	-	-	-	-	-	-	7v	-	
MELIACEAE											
†*Melia azedarach* var. *australasica*	T	PE	-	-	3	4	5	6v	-	-	
MENISPERMACEAE											
Stephania japonica var. *discolor*	C	PE	-	2v	-	-	-	-	-	-	
MONIMIACEAE											
‡*Daphnandra* sp. A	PE		-	-	-	-	-	-	-	-	Ehv
MORACEAE											
‡**Ficus carica*	T	PE	1	-	-	-	-	6v	-	8	
Ficus coronata	T	PE	-	-	-	-	-	-	-	-	Ehv
Ficus rubiginosa	T	PE	1	2	3	4	5	6v	-	-	
MYOPORACEAE											
Eremophila debilis	F	PE	1	-	-	-	-	6v	7	-	
Myoporum montanum	LS	PE	-	2	-	4v	-	6v	-	-	
MYRTACEAE											
Angophora floribunda	T	PE	1	2	3	4	5	6v	-	8	
Callistemon sieberi	TS	PE	-	2v	-	-	-	-	-	-	
‡*Callistemon* sp. (unnamed)	TS	PE	1v	-	-	-	-	-	-	-	
Calytrix tetragona	LS	PE	-	2v	-	-	-	-	-	8v	
Eucalyptus albens	T	PE	-	2	3	4	-	6v	7	8	
Eucalyptus albens–*E. moluccana* intermediate	T	PE	-	-	-	-	-	-	-	-	Egv
Eucalyptus blakelyi	T	PE	-	-	-	4	-	6v	-	8	
Eucalyptus bridgesiana–*E. malacoxylon* intermediate	T	PE	-	-	-	-	-	-	-	-	Ehv

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Eucalyptus caleyi subsp. _caleyi_	T	PE	-	2v	-	4	-	-	-	8v	
Eucalyptus camaldulensis	T	PE	-	2	-	-	-	-	-	-	Bev
Eucalyptus conica	T	PE	-	-	-	-	-	-	-	-	Cdv
Eucalyptus crebra	T	PE	-	-	-	-	-	-	-	-	Cbv
Eucalyptus cypellocarpa	T	PE	-	-	-	-	-	-	-	-	Ee
Eucalyptus dealbata	T	PE	-	2	-	4v	5	-	-	8v	
Eucalyptus fibrosa subsp. _nubila_	T	PE	-	-	-	-	-	-	-	-	Ei
Eucalyptus laevopinea	T	PE	-	2	-	4v	-	-	-	8v	
Eucalyptus melanophloia	T	PE	-	2v	-	-	-	-	-	-	
Eucalyptus melliodora	T	PE	1v	2	-	4	5	-	-	8	
Eucalyptus moluccana	T	PE	1	-	-	-	-	-	-	-	Bcv
Eucalyptus nortonii	T	PE	-	-	-	-	-	-	-	8v	
‡_Eucalyptus obliqua_	T	PE	-	-	-	-	-	-	-	-	Eiv
Eucalyptus populnea subsp. _bimbil_	T	PE	-	-	-	-	-	-	-	-	Bev
Eucalyptus prava	T	PE	-	2v	-	4	-	-	-	-	
Eucalyptus sideroxylon	T	PE	-	-	-	-	-	-	-	-	Cbv
‡_Eucalyptus viminalis_	T	PE	-	-	-	-	-	-	-	-	Egv
‡_Eucalyptus_ sp. (previously confused with _E. macrorhyncha_)	T	PE	1v	-	-	-	-	-	-	-	
Leptospermum brevipes	TS	PE	-	2v	-	-	-	-	-	-	
‡_Leptospermum polygalifolium_ subsp. _montanum_	TS	PE	-	-	-	-	-	-	-	-	Ehv
Melaleuca bracteata	TS	PE	-	2v	-	-	-	-	-	-	
NYCTAGINACEAE											
Boerhavia dominii	F	PE	1	2	3	4	5	6v	7	8	
OLEACEAE											
‡*_Fraxinus angustifolia_ subsp. _angustifolia_	T	PE	-	-	-	-	-	-	-	-	Dfv
Jasminum lineare	LS	PE	-	2	3	4	-	6v	-	-	
‡*_Jasminum mesnyi_	LS	PE	-	-	-	-	-	6v	-	8	
Jasminum suavissimum	LS	PE	-	2	3	-	-	6v	-	8	
*_Ligustrum lucidum_	TS	PE	-	-	3	-	5	6v	-	-	
*_Ligustrum sinense_	TS	PE	-	-	-	4v	-	6v	-	-	
‡*_Ligustrum vulgare_	TS	PE	-	-	-	-	-	-	-	-	Eiv
Notelaea microcarpa var. _microcarpa_	T	PE	1	2	3	4	5	6v	7	8	
‡*_Olea europaea_ subsp. _africana_	T	PE	-	-	-	4	-	6v	-	-	
ONAGRACEAE											
Epilobium billardierianum subsp. _cinereum_	F	PE	1	2v	-	4v	5	6v	-	8v	
‡_Epilobium billardierianum_ subsp. _hydrophilum_	F	PE	-	-	-	-	-	-	-	-	Ehv
Ludwigia peploides subsp. _montevidensis_	F	PE	1	2v	-	-	-	-	-	-	
*_Oenothera affinis_	F	AN	1	-	-	4	5v	6v	-	8	
*_Oenothera glazioviana_	F	SP	-	2v	-	-	-	-	-	-	
*_Oenothera indecora_ subsp. _bonariensis_	F	AN	-	2v	-	4v	5v	-	-	8v	
OXALIDACEAE											
‡*_Oxalis bowiei_	F	PE	-	-	-	-	-	6v	-	-	
*_Oxalis brasiliensis_	F	PE	-	2v	-	-	-	-	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Oxalis chnoödes	F	PE	-	2v	-	-	-	-	-	-	
Oxalis exilis	F	PE	1	2v	3	4	5	6v	7	8	
Oxalis perennans	F	PE	1v	2v	-	4v	-	6	7v	-	
**Oxalis pes-caprae*	F	PE	-	-	-	-	-	6v	-	-	
Oxalis radicosa	F	PE	1v	-	-	-	5v	-	-	8	
PAPAVERACEAE											
**Argemone ochroleuca* subsp. *ochroleuca*	F	AN	1	2	3	4	5	6v	7	8	
**Argemone subfusiformis* subsp. *subfusiformis*	F	AN	-	-	-	-	-	-	-	8v	
**Eschscholzia californica*	F	AN	-	-	-	-	-	-	-	-	Dfv
**Papaver aculeatum*	F	AN	1	2	-	4	5	6	-	8v	
‡**Papaver dubium*	F	AN	-	-	-	-	-	-	-	-	Egv
**Papaver hybridum*	F	AN	-	-	3	-	-	-	7	-	Efv
‡**Papaver rhoeas*	F	AN	-	-	3	-	-	-	-	-	
**Papaver somniferum* subsp. *setigerum*	F	AN	1	-	3	4	5	6v	-	8	
PHYTOLACCACEAE											
**Phytolacca octandra*	F	PE	1	-	-	-	-	6	-	8	Efv
PITTOSPORACEAE											
Bursaria spinosa	TS	PE	1	2	3	4	5	6v	-	8	
Pittosporum phylliraeoides	LS	PE	-	-	3	4v	-	6v	-	-	
Pittosporum undulatum	T	PE	-	-	-	-	-	-	-	-	Ehv
PLANTAGINACEAE											
Plantago debilis	F	SP	1	2	3	4v	5	6v	7	8	
**Plantago lanceolata*	F	SP	1	2	3	4	5	6v	-	8	
**Plantago scabra*	F	AN	1v	-	-	-	-	-	-	-	
‡*Plantago turrifera*	F	AN	1v	-	-	-	-	-	-	-	
PLUMBAGINACEAE											
‡**Limonium sinuatum*	F	PE	-	-	-	-	-	-	-	-	Egv
POLYGALACEAE											
Polygala japonica	F	PE	-	-	-	-	-	-	-	8v	
POLYGONACEAE											
**Acetosa vesicaria*	F	AN	-	-	-	-	-	-	-	-	Aev
**Acetosella vulgaris* s. lat.	F	PE	-	2v	-	-	5	-	-	8	
**Emex australis*	F	AN	-	-	-	-	-	6v	-	-	
**Fallopia convolvulus*	F	AN	-	-	-	-	-	-	-	-	Dfv
Muehlenbeckia florulenta	LS	PE	-	-	-	-	-	-	-	-	Bfv
Persicaria hydropiper	F	AN	1v	2v	-	-	-	-	-	-	
Persicaria lapathifolia	F	AN	1	2v	-	4v	-	6v	-	8	
Persicaria orientalis	F	AN	-	-	-	-	-	-	-	-	Bdv
Persicaria prostrata	F	PE	-	2v	-	-	-	-	-	8	
**Polygonum arenastrum*	F	SP	-	-	-	-	-	-	-	-	Eiv
**Polygonum aviculare*	F	SP	1	2	3	4	5	6v	7	8	
Polygonum patulum	F	AN	-	-	-	-	5	-	7v	-	
Polygonum plebeium	F	AN	-	-	-	-	-	-	-	8v	
Rumex brownii	F	PE	1	2	3	4	5	6v	7	8	
‡**Rumex conglomeratus*	F	PE	1	2v		4	-	-	-	8v	
**Rumex crispus*	F	PE	1	2	3	-	5	6v	7	8	
PORTULACACEAE											
Calandrinia eremaea	F	AN	-	2v	-	4v	5	-	-	8	
Portulaca bicolor var. *rosea*	F	AN	-	-	-	4v	-	-	-	-	
Portulaca oleracea	F	AN	1	2	3	4	5	6v	7	8v	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
‡**Portulaca pilosa*	F	AN	-	-	-	-	-	-	-	-	Bbv
Portulaca sp.	F	AN	-	2v	-	-	-	-	-	-	
PRIMULACEAE											
**Anagallis arvensis* blue-flowered form	F	SP	1	2	3	4	5	6v	7	-	
**Anagallis arvensis* red-flowered form	F	SP	1	2	3	4	-	6v	7	8	
‡*Samolus valerandi*	F	PE	1v	-	-	-	-	-	-	-	
PROTEACEAE											
Grevillea floribunda	LS	PE	-	2v	-	-	-	-	-	-	
†*Grevillea robusta*	T	PE	-	-	-	-	5	6v	-	8	
Grevillea triternata	LS	PE	-	2v	-	-	-	-	-	-	
Hakea eriantha	TS	PE	-	2v	-	-	-	-	-	-	
Hakea pulvinifera	TS	PE	-	-	-	-	-	-	-	-	Aev
Persoonia cornifolia	TS	PE	-	2v	-	-	-	-	-	-	
RANUNCULACEAE											
**Adonis microcarpa*	F	AN	-	-	-	-	-	-	-	-	Dfv
Clematis glycinoides var. *glycinoides*	C	PE	-	2	-	4	5	6v	-	8	
Clematis microphylla var. *microphylla*	C	PE	-	2	3	-	-	6v	-	8	
Ranunculus lappaceus	F	PE	1v	2	-	4v	-	6v	-	8	
Ranunculus pumilio var. *pumilio*	F	AN	-	-	-	4v	-	-	-	-	
Ranunculus sessiliflorus var. *sessiliflorus*	F	AN	1	2	-	4v	5	6v	-	8	
Ranunculus sp. A (aff. *undosus*)	F	AN	1v	-	-	4	-	-	-	-	
RESEDACEAE											
**Reseda lutea*	F	PE	-	-	-	-	-	-	-	-	Df
**Reseda luteola*	F	PE	-	-	-	-	-	-	-	-	Egv
RHAMNACEAE											
Alphitonia excelsa	T	PE	-	2	3	4v	-	-	-	-	
Cryptandra amara var. *amara*	LS	PE	1	-	-	-	-	-	-	8v	
Cryptandra amara var. *longiflora*	LS	PE	-	-	-	-	-	-	-	-	Egv
Cryptandra scortechinii	LS	PE	1v	-	-	-	-	-	-	-	
Pomaderris angustifolia	TS	PE	-	2v	-	-	-	-	-	-	
Pomaderris eriocephala	TS	PE	1v	-	-	-	-	-	-	-	
ROSACEAE (s. str.)											
Acaena novae-zelandiae	F	PE	-	-	-	-	-	6v	-	8	
Acaena ovina s. str.	F	PE	-	-	-	-	-	6v	-	8	
**Aphanes arvensis*	F	AN	-	-	-	-	-	-	-	-	Ehv
Aphanes australiana	F	AN	-	2v	-	4v	5	6v	-	8	
**Rosa rubiginosa*	LS	PE	1	2	-	4	5	6v	-	8	
‡**Rosa* sp.	LS	PE	-	-	-	-	-	6v	-	-	
**Rubus discolor*	LS	PE	1	2	-	4	5	-	-	8v	
Rubus parvifolius	LS	PE	1	2	3	4	5	6v	-	8	
**Sanguisorba minor* subsp. *muricata*	F	PE	-	-	-	-	-	-	-	-	Ehv
RUBIACEAE											
Asperula conferta	F	PE	-	2	-	4v	-	6v	7	8	
Asperula cunninghamii	F	PE	1v	-	-	-	-	-	-	-	
Canthium odoratum	T	PE	-	2	3	4	-	6v	-	-	
Canthium oleifolium	T	PE	1v	-	-	-	-	-	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
*_Galium aparine_	F	AN	-	2	3	4	5	6v	7	8	
Galium gaudichaudii	F	PE	-	2	3	4v	5	6v	-	8	
Galium migrans	F	PE	1	2	3	4v	5	6v	-	8	
*_Galium murale_	F	AN	1v	2	-	4	-	6v	-	8	
Opercularia diphylla	F	PE	-	-	-	-	-	-	-	-	Ehv
Opercularia hispida	F	PE	-	2	-	4v	-	-	-	-	
Pomax umbellata	LS	PE	-	2v	-	-	-	-	-	-	
*_Richardia stellaris_	F	PE	-	2v	-	-	-	-	-	-	
*_Sherardia arvensis_	F	AN	-	-	-	-	-	6v	-	8v	
RUTACEAE											
Boronia ruppii s. str.	LS	PE	1v	-	-	-	-	-	-	-	
*_Citrus limonia_ s. lat.	T	PE	-	-	-	-	-	6	-	-	
Correa reflexa var. _reflexa_	LS	PE	-	2	-	4v	-	-	-	-	
Geijera parviflora	TS	PE	-	-	3	-	-	-	-	-	Dfv
‡_Melicope micrococca_	T	PE	-	-	-	-	-	-	-	-	Ehv
Zieria cystisoides	LS	PE	-	-	-	-	-	-	-	8v	
SALICACEAE											
‡*_Populus alba_	T	PE	-	-	-	-	-	-	-	-	Dfv
*_Populus nigra_	T	PE	-	-	-	-	-	-	-	-	Ehv
‡*_Salix fragilis_ var. _fragilis_	T	PE	-	-	-	-	-	-	-	-	Dfv
‡*_Salix_ × _sepulcralis_ var. _sepulcralis_ (_Salix babylonicus_ misapplied)	T	PE	-	2v	-	-	-	-	-	8	
‡*_Salix_ × _sepulcralis_ var. _sepulcralis_ × _Salix fragilis_ var. _fragilis_	T	PE	-	2v	-	-	-	-	-	-	
SAMBUCACEAE											
Sambucus australasica	LS	PE	-	-	-	-	-	6v	-	-	
SANTALACEAE											
Exocarpos cupressiformis	HP	PE	-	2	-	4	-	6v	-	8	
Santalum lanceolatum	HP	PE	1	-	3v	-	-	6	-	8	
SAPINDACEAE											
Alectryon forsythii	TS	PE	-	-	-	-	-	6v	-	-	
Alectryon oleifolius subsp. _elongatus_	T	PE	-	-	-	-	-	-	-	-	Dev
*_Cardiospermum grandiflorum_	C	PE	-	-	-	-	-	6v	-	-	
Dodonaea boroniifolia	LS	PE	1v	-	-	-	-	-	-	-	
Dodonaea sinuolata subsp. _sinuolata_	LS	PE	-	-	-	-	-	-	-	-	Ehv
Dodonaea viscosa subsp. _angustifolia_	TS	PE	1	2	3	4	-	6v	-	8	
Dodonaea viscosa subsp. _angustissima_	TS	PE	-	2	-	4v	-	-	-	-	
SCROPHULARIACEAE											
Derwentia arenaria	F	PE	-	2v	-	-	-	-	-	-	
Glossostigma elatinoides	F	PE	-	2v	-	-	-	-	-	-	
‡_Gratiola pedunculata_	F	PE	-	2v	-	-	-	-	-	-	
Gratiola peruviana	F	PE	-	2v	-	-	-	-	-	-	
*_Kickxia spuria_ subsp. _integrifolia_	F	PE	-	-	-	-	-	-	-	-	Cfv
Limosella australis	F	PE	-	-	-	4v	-	-	-	-	
Limosella curdieana	F	PE	-	-	-	4v	-	-	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
*_Linaria arvensis_	F	AN	1	2v	3	4	5	6v	-	8	
*_Linaria pelisseriana_	F	AN	-	2v	-	4v	5	-	-	-	
Mimulus gracilis	F	PE	1v	-	-	4v	-	-	-	-	
‡_Mimulus repens_	F	PE	-	2v	-	-	-	-	-	-	
*_Misopates orontium_	F	AN	-	2	3	4	5	6v	-	8	
‡_Striga parviflora_	P	AN	-	-	-	-	-	-	-	-	Ehv
*_Verbascum thapsus_ subsp. _thapsus_	F	SP	1	2	-	4	5	6	-	8	
*_Verbascum virgatum_	F	SP	1	2	3	4	5	6v	-	8	
‡*_Veronica anagallis-aquatica_	F	PE	1v	-	-	-	-	-	-	-	
*_Veronica arvensis_	F	AN	1	2v	-	4	5	6v	-	8	
*_Veronica persica_	F	AN	-	-	3	-	-	6v	-	8	
Veronica plebeia	F	PE	1	2	3	4	-	6v	-	8	
SIMAROUBACEAE											
*_Ailanthus altissima_	T	PE	1	-	3	4	-	6v	-	8	
SOLANACEAE											
*_Calibrachoa parviflora_	F	SP	-	-	-	-	-	-	-	-	Bev
*_Cestrum parqui_	LS	PE	-	-	-	-	5	6v	-	-	
*_Datura ferox_	F	AN	-	2	3	-	-	6v	-	8	
*_Datura stramonium_	F	AN	1	2	3	-	-	6v	7	8	
*_Lycium ferocissimum_	TS	PE	-	-	-	-	5	6v	-	-	
*_Nicotiana glauca_	TS	PE	-	-	3v	-	-	-	-	-	
Nicotiana suaveolens	F	PE	1v	-	-	-	-	-	-	-	
*_Petunia axillaris_	F	SP	-	-	-	-	-	6v	-	-	
*_Physalis ixocarpa_	F	AN	-	-	3v	-	-	-	7v	-	
*_Physalis virginiana_	F	PE	-	-	-	-	-	-	-	-	Cev
‡*_Solanum chenopodioides_	F	AN	1v	2	-	-	5v	-	-	-	
Solanum cinereum	F	PE	1	2v	3	4v	5	6	-	-	
*_Solanum elaeagnifolium_	F	PE	-	-	-	-	-	-	-	-	Dfv
Solanum esuriale	F	PE	-	-	-	-	-	-	7v	-	
*_Solanum nigrum_	F	SP	1	2	3	4	5	6	7	8v	
Solanum opacum	F	AN	-	2	-	-	-	-	-	-	
Solanum parvifolium	LS	PE	-	2v	-	4v	-	6v	-	-	
Solanum prinophyllum	F	SP	-	-	-	-	-	-	-	8v	
*_Solanum pseudocapsicum_	LS	PE	-	-	3	-	-	6v	-	8	
‡*_Solanum radicans_	F	SP	-	-	-	-	-	-	-	-	Dfv
*_Solanum rostratum_	F	AN	-	-	-	-	-	-	-	-	Cev-
*_Solanum triflorum_	F	AN	-	-	-	-	-	-	-	-	Dfv
Solanum vescum	LS	PE	-	-	-	-	-	-	-	-	Ddv
STACKHOUSIACEAE											
Stackhousia monogyna	F	PE	1	2v	3	4	-	6v	-	8	
Stackhousia viminea	F	PE	1v	2	-	4v	5	6v	7	-	
STERCULIACEAE											
Brachychiton populneus	T	PE	1	2	3	4	5	6v	-	8	
THYMELAEACEAE											
Pimelea curviflora var. _divergens_	LS	PE	-	-	-	-	-	6v	-	-	
Pimelea curviflora var. _sericea_	LS	PE	-	2v	-	4	-	-	-	-	
Pimelea linifolia subsp. _linifolia_	LS	PE	1v	-	-	-	-	6v	-	8v	
Pimelea micrantha	LS	PE	-	-	3	-	-	6v	-	-	
Pimelea neo-anglica	LS	PE	1v	2v	-	4	-	-	7v	-	
Pimelea strigosa	LS	PE	-	2v	-	4v	-	6v	-	-	
ULMACEAE											
‡*_Celtis australis_	T	PE	-	-	-	-	-	6v	-	-	

Species	**Life form**	**Life cycle**	**Site**								**Other**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Trema aspera	TS	PE	-	2v	-	-	-	-	-	-	
URTICACEAE											
Parietaria debilis	F	AN	-	2v	-	4v	-	6v	-	8	
**Parietaria judaica*	F	PE	-	-	-	-	-	-	-	-	Df
Urtica incisa	F	PE	1	2	3	4	5	6v	7	8	
**Urtica urens*	F	PE	-	2	3	-	5	-	7	8	Dfv
VALERIANACEAE											
**Centranthus ruber* subsp. *ruber*	F	PE	-	-	-	-	-	6v	-	-	
VERBENACEAE											
**Lantana montevidensis*	F	PE	-	-	-	-	-	6v	-	-	
Oncinocalyx betchei	F	PE	-	-	-	4	5	6v	-	8	
‡**Phyla canescens*	F	PE	-	-	-	-	-	-	-	-	Aev
**Verbena aristigera* (= *V. tenuisecta*)	F	PE	-	-	3	4	5	6v	-	-	
**Verbena bonariensis*	F	PE	-	2	-	-	-	-	-	8v	
‡**Verbena caracasana*	F	PE	-	2	-	4	5	6v	-	8	
Verbena gaudichaudii (previously confused with *V. officinalis*)	F	PE	-	2	3	-	5	6v	-	8	
**Verbena hispida*	F	PE	-	-	-	-	-	-	-	-	Egv
‡**Verbena incompta* (previously included in *V. bonariensis*)	F	PE	1	2v	3	4	5	6v	7	8	
‡**Verbena quadrangularis* (= *V. brasiliensis*)	F	PE	-	-	-	-	-	6v	-	-	
**Verbena rigida*	F	PE	1	-	-	-	5	-	-	-	Cbv
VIOLACEAE											
Hybanthus monopetalus	F	PE	-	-	-	-	-	-	-	-	Eiv
Hymenanthera dentata	TS	PE	-	-	-	-	-	-	-	-	Fgv
‡**Viola arvensis*	F	PE	-	-	-	-	-	6	-	-	
Viola betonicifolia subsp. *betonicifolia*	F	PE	1v	2v	-	4	-	-	-	8	
**Viola odorata*	F	PE	-	-	-	-	-	6v	-	-	
VISCACEAE											
Korthalsella rubra subsp. *geijericola*	P	PE	-	-	-	-	-	-	-	-	Bfv
Notothixos cornifolius	P	PE	-	2v	-	4		6	-	8v	
Notothixos subaureus	P	PE	-	-	-	-	-	-	-	-	Ehv
VITACEAE											
Cayratia clematidea	C	PE	-	2	3	4	-	6v	-	-	
Cissus opaca	C	PE	-	-	3	4	-	6v	-	-	
ZYGOPHYLLACEAE											
Tribulus micrococcus	F	AN	1	2	3	-	-	6	7	8	Dfv
**Tribulus terrestris*	F	AN	1	2	3	4	5	6v	7	8	

2. Warrabah National Park

Warrabah National Park covers 3471 hectares of the Namoi River valley, to the east of Manilla. Surveys were undertaken only in the western half of the Park (between 30°32'S and 30°35'S and 150°54'E and 150°57'E), due to problems of access elsewhere. Altitude varied from 425 m to 900 m. The Park is on New England adamellites (granitic rocks), which weather to produce a well-drained, coarse to fine sandy and infertile soil.

Eucalypt woodland to open-forest communities predominate with *Casuarina cunninghamiana* subsp. *cunninghamiana* growing along the river, and *Callitris glaucophylla* common on the slopes, along with several species of *Eucalyptus* (Fig. 3). The shrub understorey varies from sparse to dense, with particularly dense growth of *Leptospermum brevipes* on slopes above the river and *Cassinia laevis* in other areas. Perennial grasses dominate the ground layer and there are often extensive bare areas during drier periods.

3. Attunga rubbish tip

The area sampled (between 30°53'S and 30°55'S and 150°54'E and 150°57'E) covered 18 hectares around Attunga rubbish tip and included the adjoining roadside. Altitude varied from 430 m to 488 m. The area is particularly disturbed with fires often escaping from the tip and burning the surrounding vegetation. Soil in this area is derived from limestone, the tip being an old limestone mine. Vegetation of the area is mainly tall shrubs and herbs with scattered trees of *Eucalyptus albens*, *Angophora floribunda* and *Ficus rubiginosa* as well as small areas of *Eucalyptus albens* woodland (Fig. 4). Low growing species are increasingly being displaced by **Hyparrhenia hirta*.

4. Attunga State Forest

Attunga State Forest covers 850 hectares (between 30°55'S and 30°58'S and 150°49'E and 150°51'E). Altitude varied from 430 m to 940 m. All areas of the forest were sampled. Soil is coarse to fine sand derived from Moonbi and Walcha Road adamellites (granitic rocks). An area previously used for gravel extraction appears to have a high clay content as pools of water with ephemeral wetland species remain in this area for a few weeks after heavy rain.

Vegetation consists mainly of grassy woodland, shrubby or layered woodland and some areas of grassy open-forest (Fig. 5). *Callitris glaucophylla*, *Angophora floribunda* and several *Eucalyptus* species are dominant in flat and gently-sloping areas, as well as on lower slopes not having a westerly aspect; *Callitris glaucophylla* is dominant on lower western-facing slopes and *Eucalyptus laevopinea* dominant in higher parts. The shrub understorey varies from absent to closed (> 70 per cent projective foliage cover) with locally conspicuous stands of *Cassinia laevis*, *Olearia elliptica* and *Dodonaea viscosa* subsp. *angustissima*. Amongst trees, shrubs and rocks, low-growing species are often sparse. An intermittent stream runs through the northern part of the forest with associated riparian communities.

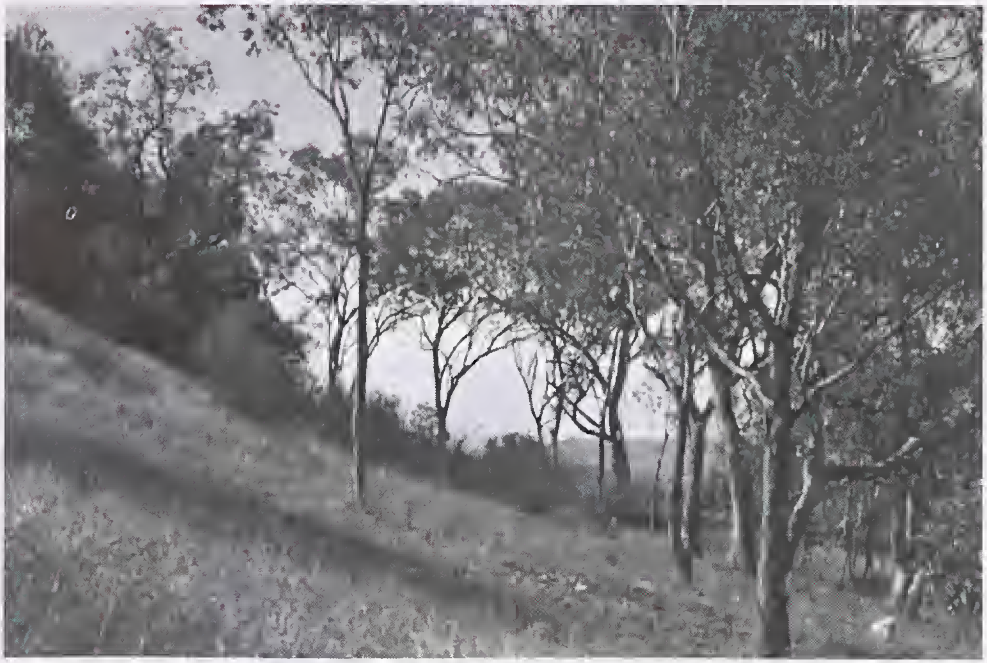

Fig. 4. The area around Attunga Rubbish Tip consists of dense stands of shrubs with some *Eucalyptus albens* woodland. The area is being increasingly invaded by the introduced grass, **Hyparrhenia hirta* (Site 3).

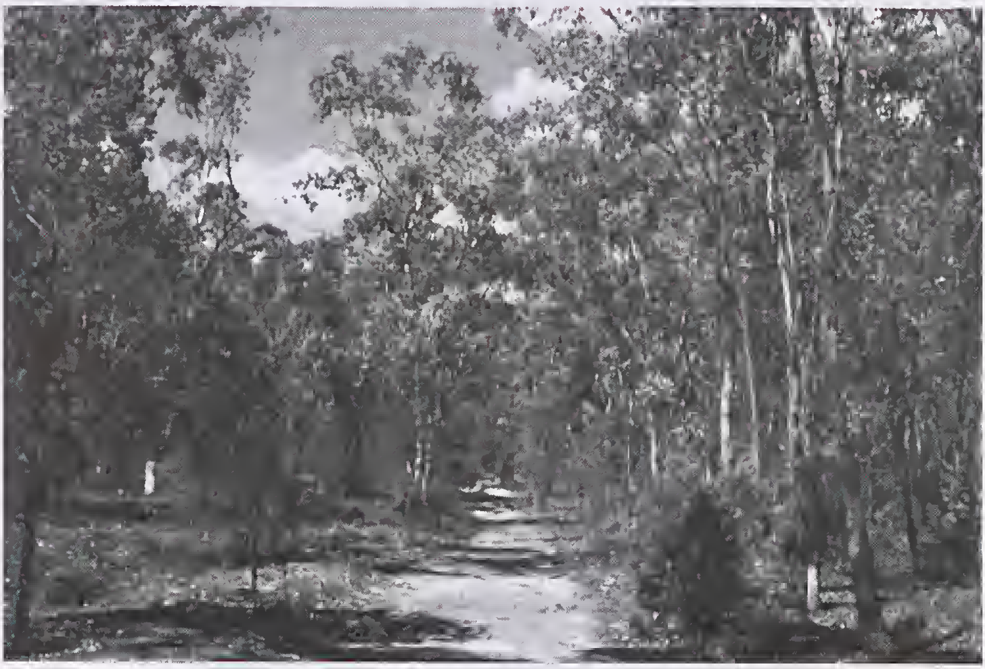

Fig. 5. Woodland of *Eucalyptus albens* with an understorey of *Callitris glaucophylla*, *Cassinia laevis* and herbs at Attunga State Forest (Site 4).

Recreational use of the forest has changed considerably during the survey period. From 1984 until the early 1990s the forest was used by day trippers from Tamworth. However, in the early 1990s trail-bike riding became popular causing significant erosion. In late 1994 New England Archery Club fenced off part of the western side of the forest (the main point of entry) and consequently discouraged both trail bike riding and bushwalking in the area.

5. Kootingal

The area sampled was grazing and cropping land (between 31°04'S and 31°05'S and 151°02'E and 151°03'E), covering approximately 14 hectares of weed-infested unimproved pasture with some areas of open-woodland (Fig. 6), and includes areas previously cropped and the roadside outside the property. Altitude varied from 415 m to 455 m. Soils are coarse to fine sands derived from Moonbi and Walcha Road adamellites. The grassy open-woodland in rocky sites is dominated by *Eucalyptus dealbata* with a sparse shrub understorey. Dominant species of ground flora include **Hyparrhenia hirta* in the rockier areas and *Aristida ramosa* on lower uncultivated land. Plant species occurring in previously cultivated areas (about half of the sample area) include *Cynodon dactylon*, *Urochloa piligera* and exotics such as **Echium plantagineum*, **Carthamus lanatus*, **Hypochaeris radicata*, **Trifolium* spp. and **Tribulus terrestris*. This area has recently been subdivided into rural residential blocks of a few hectares each.

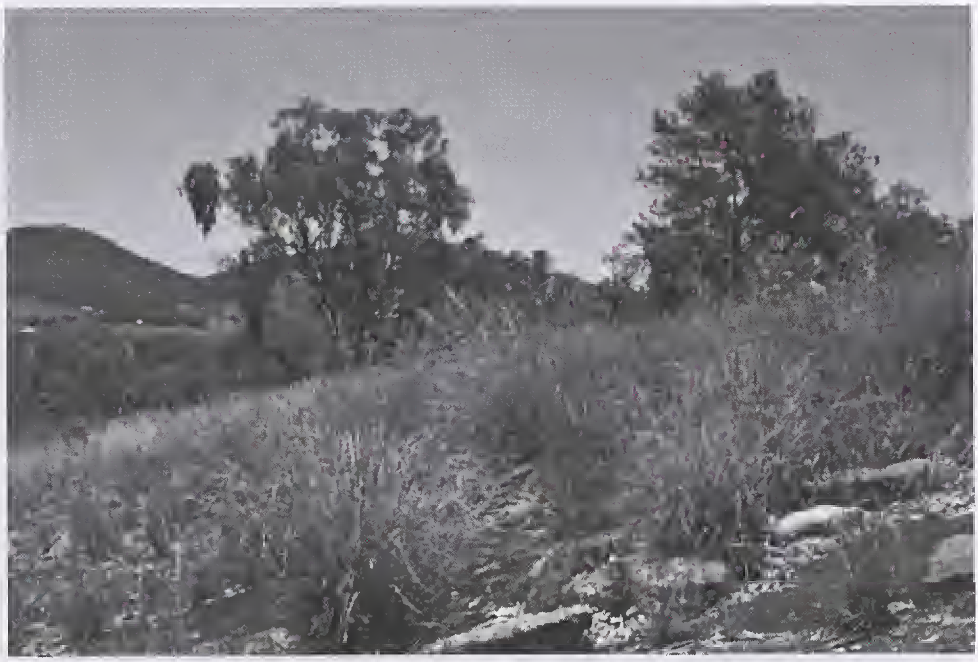

Fig. 6. Open-woodland of *Eucalyptus dealbata* with scattered *Callitris glaucophylla* on grazing land near Kootingal. The herb layer is being invaded by *H*yparrhenia hirta* which is visible in the foreground (Site 5).

6. Oxley Park, Tamworth

Oxley Park covers 521 hectares (between 31°04'S and 31°07'S and 150°56'E and 150° 59'E), on hills to the north of Tamworth. Altitude varied from 400 m to 831 m. All areas of the Park were sampled. Soil is a red to brown loam derived from greywacke (compressed sediments).

Woodland to open-forest communities are dominated by *Eucalyptus albens* (Fig. 7) with *Callitris glaucophylla* locally common along the western side of the Park. The shrub layer is often poorly developed. *Cassinia quinquefaria, Olearia elliptica, Olearia viscidula, Dodonaea viscosa* subsp. *angustifolia* and *Acacia decora* are locally common. The ground flora is diverse with *Aristida ramosa* being one of the more common species. Some of the sheltered gullies have dry rainforest species forming vine thickets. Further floristic information is provided in Hosking (1990).

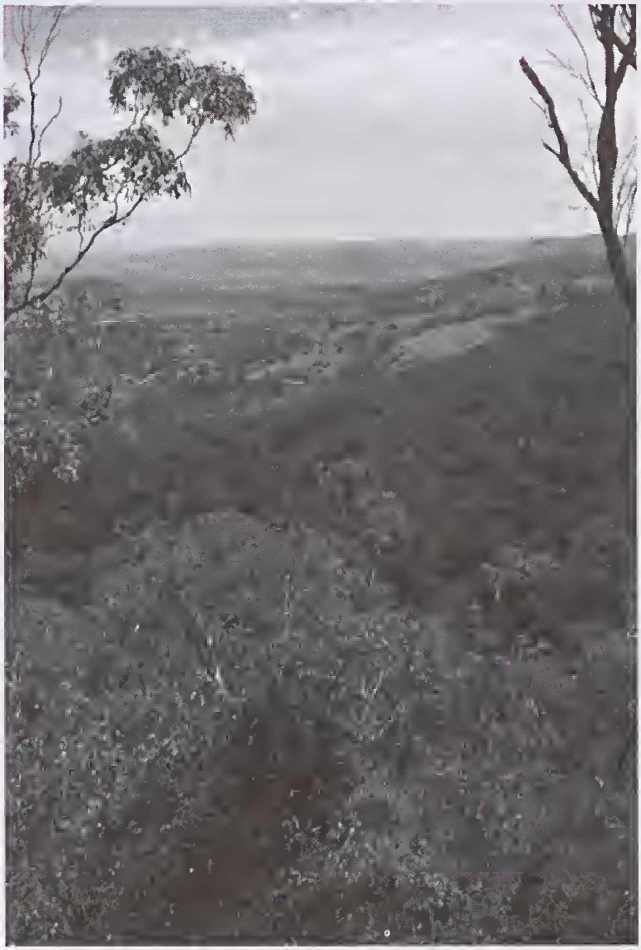

Fig. 7. Oxley Park is predominantly *Eucalyptus albens* woodland to open-forest (Site 6).

7. Duri

The area sampled was a roadside 10 km north west of Duri, comprising about 3 hectares on both sides of 1 km of road (from 31°09'53"S, 150°44'43"E to 31°09'43"S, 150°44'03"E). Altitude varied from 460 m to 470 m. The soil is a black cracking clay.

The area is predominantly grassland with occasional shrubs of *Acacia implexa* and *Acacia salicina*, and scattered trees of *Eucalyptus albens* and **Schinus areira* (Fig. 8). The ground flora is dominated by grasses with *Dichanthium setosum* being particularly common. **Hyparrhenia hirta* is beginning to encroach on the western end of the area sampled. Roadside grading of this area in 1995 removed much of the original herb layer and the area now appears to have a greater proportion of introduced species.

8. Chaffey Dam

The area sampled comprised about 210 hectares on the northern side of Chaffey Dam (between 31°20'S and 31°21'S and 151°07'E and 150°09'E), including the jasper ridge that was extended to form the wall for the dam. Plant species growing alongside the Peel River in the area below the dam wall are also included. Altitude varied from 485 m to 712 m. Jasper weathers to form a well-drained red to brown loam.

The site consists of woodland to open-forest (Fig. 9) with some areas of grassland. The southern slopes are dominated by *Eucalyptus laevopinea* with a sparse understorey of shrubs with *Acacia implexa* as the most common species. The ground flora is dominated by grasses with *Aristida ramosa* being particularly common. Northern slopes support *Eucalyptus albens* woodland, similar to that found in Oxley Park.

Prior to construction of Chaffey Dam the area was grazing land, but now much of the area is only grazed by native animals and rabbits. A report by White et al. (1990) on vegetation which would be flooded by an enlargement of Chaffey Dam covers some of the vegetation in lower parts of this study area, but also covers areas not included in the present study.

Results and Discussion

Table 2 lists vascular plant taxa for the study area. A total of 1041 taxa was recorded (639 native to area, 8 Australian but not native to area, 394 exotic) representing 11% of the native taxa and 30% of the exotic naturalised taxa of New South Wales (based on taxa in Harden 1990–93, see Table 3). The plant families with greatest representation within the study area are Poaceae, Asteraceae and Fabaceae (Table 4). The number of taxa recorded at each site is shown in Table 5. Species richness increased with size of site sampled and habitat diversity, with Warrabah National Park, the largest (3741 ha) and most diverse of the eight sites, with 507 plant taxa, and the roadside north west of Duri (3 ha) with only 183 taxa.

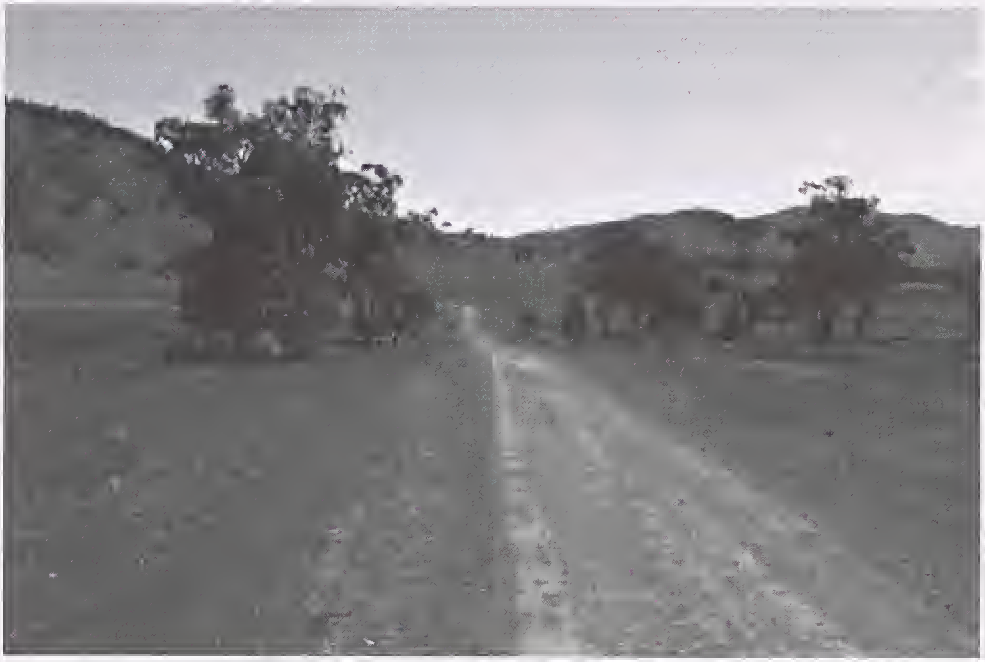

Fig. 8. Roadside area north west of Duri consisting of grassland with occasional shrubs of *Acacia implexa* and *Acacia salicina* and a few *Eucalyptus albens* trees (Site 7).

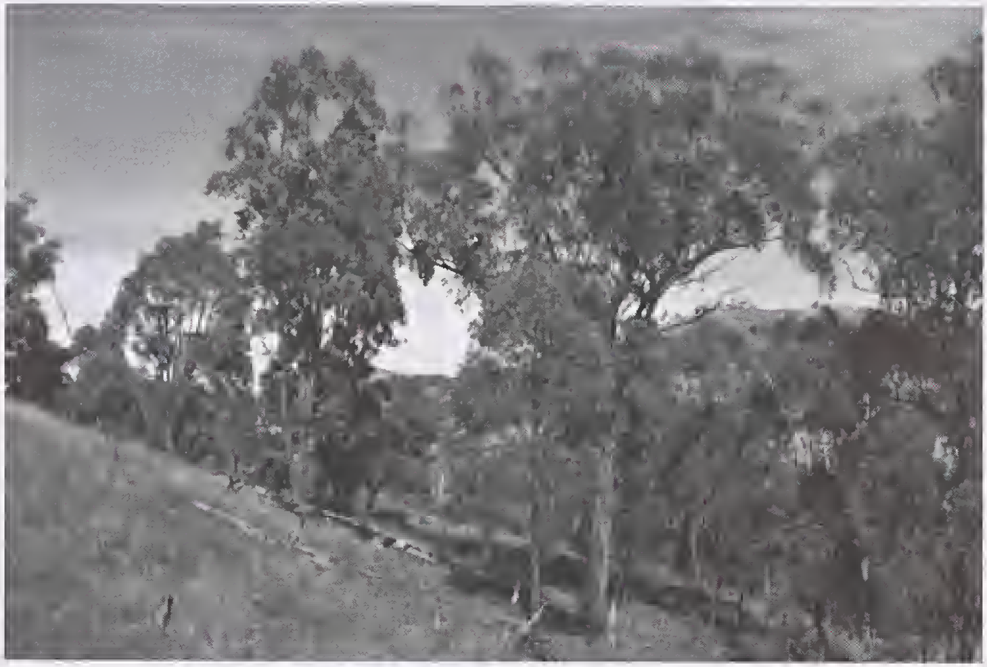

Fig. 9. Woodland to open-forest of *Eucalyptus laevopinea* with *Acacia implexa* as the main understorey shrub on a ridge to the north of Chaffey Dam (Site 8).

Table 3. Number of vascular plant taxa found in this study in relation to the vascular plant taxa of New South Wales (Harden 1990–93).

Plant group	No. native taxa (species) NWS[1]	No. native taxa (species) NSW[2]	No. exotic taxa (species) NWS[1]	No. exotic taxa (species) NSW[2]	Total taxa (species) NWS[1]	Total taxa (species) NSW[2]
Pteridophytes	16 (16)	183 (180)	-	4 (4)	16 (16)	187 (184)
Gymnosperms	3 (3)	31 (28)	1 (1)	4 (4)	4 (4)	35 (32)
Angiosperms (Monocotyledons)	203 (194)	1376 (1316)	97 (96)	329 (317)	300 (290)	1705 (1633)
Angiosperms (Dicotyledons)	425 (413)	4094 (3755)	296 (293)	987 (968)	721 (706)	5081 (4723)
Total	647 (626)	5684 (5279)	394 (390)	1324 (1293)	1041 (1016)	7008 (6572)

[1] NWS = North Western Slopes in this study
[2] NSW = New South Wales from Harden (1990–93)

Table 4. Plant families with 10 or more taxa in the study area showing the numbers and proportions of native and naturalised exotic species.

Family	Total no. of taxa	No. of native taxa	% of native taxa	No. of exotic taxa	% of exotic taxa
Poaceae	156	87	55.8	69	44.2
Asteraceae	118	66	55.9	52	44.1
Fabaceae	96	61	63.5	35	36.5
Cyperaceae	45	40	88.9	5	11.1
Myrtaceae	29	29	100.0	0	0
Solanaceae	23	7	30.4	16	69.6
Orchidaceae	22	22	100.0	0	0
Caryophyllaceae	19	4	21.1	15	78.9
Scrophulariaceae	19	10	52.6	9	47.4
Euphorbiaceae	18	14	77.8	4	22.2
Juncaceae	18	15	83.3	3	16.7
Brassicaceae	17	5	29.4	12	70.6
Lamiaceae	17	11	64.7	6	35.3
Polygonaceae	16	7	43.7	9	56.3
Malvaceae	15	8	53.3	7	46.6
Chenopodiaceae	14	12	85.7	2	14.3
Rubiaceae	13	9	69.2	4	30.8
Apiaceae	11	5	45.5	6	54.5
Verbenaceae	11	2	18.2	9	81.8
Amaranthaceae	10	5	50.0	5	50.0
Boraginaceae	10	5	50.0	5	50.0
Loranthaceae	10	10	100.0	0	0
Malaceae	10	0	0	10	100.0

Table 5. Summary of site details and number of vascular plant taxa at each site and overall in this study, showing the number of native and naturalised exotic taxa.

Site	Substrate; soil	Vegetation	Landuse	Area of site (ha)	Total no. of taxa	No. of native taxa (%)	No. of exotic taxa (%)
1 around Woodsreef mine	mainly serpentinite; grey to brown loam	mainly grassy *Eucalyptus* sp. (unnamed stringybark) woodland	mostly grazing with ungrazed roadside areas	150	382	238 (62)	144 (38)
2 Warrabah National Park	New England adamellites; mainly grey to brown sandy soil	various woodland to open-forest communities	recreation and conservation –– previously rough grazing	3471	507	351 (69)	156 (31)
3 around Attunga rubbish tip	limestone; grey to brown loam	mostly shrubland with some *Eucalyptus albens* woodland	rubbish tip and ungrazed surrounds	18	266	134 (50)	132 (50)
4. Attunga State Forest	Moonbi and Walcha Road adamellites; mainly grey to brown sandy soil	various woodland to open-forest communities	mainly recreation	850	410	266 (65)	144 (35)
5. grazing land near Kootingal	Moonbi and Walcha Road adamellites; mainly grey to brown sandy soil	grassy *Eucalyptus dealbata* open-woodland and cleared grazing and cropping	grazing, previously also cropping, and roadside areas	14	265	135 (51)	13 (49)
6. Oxley Park Tamworth	greywacke; red to brown sometimes skeletal	mainly *Eucalyptus albens* woodland to open-forest	recreation and conservation	521	467	248 (53)	219 (47)
7 roadside north west of Duri	no substrate visible; black cracking clay soil	predominantly grassland	roadside only grazed during droughts	3	183	89 (49)	94 (51)
8. northern side of Chaffey Dam	mainly jasper; red to brown loam	mainly woodland to open-forest with *Eucalyptus albens* and *Eucalyptus laevopinea* as the most common trees	recreation, previously grazing	210	406	232 (57)	174 (43)
Total for area				620,000	1041	647 (62)	394 (38)

Despite the long history of disturbance, a high number of native species was recorded (626), comprising 62% of the total number of species. This species richness reflects the diversity of landforms, geology and climate within the region as well as the natural resilience of many of the native species. The highest number of native taxa was found in Warrabah National Park (351 taxa) and Attunga State Forest (266 taxa).

The primary survey sites covered a range of soil types. A number of species were found at all these sites and others appeared to be confined to particular soil types, for example, those on serpentinite soils in the Woodsreef area. The most fertile sites, Duri (site 7), Chaffey Dam (site 8) and Oxley Park (site 6) were also some of the most disturbed and recorded high numbers of exotic taxa (> 40%). The importance of roadside corridors in protecting local biodiversity is supported by the floristics of site 7, west of Duri. Within an area of 3 ha there were 89 native taxa recorded, including two species of national and state significance.

Exotic taxa

About 38% of the plant taxa recorded are exotics naturalised in the area. This is a relatively high proportion in comparison with figures of almost 19% for flora of New South Wales (Harden 1990–93), 28% for Victoria (Carr 1993) and almost 27% for South Australia (Toelken 1987). A study of species mainly occurring along roadsides from Duri Peak (south west of site 7) to 'Head of Peel' (south of site 8 and on the edge of the Northern Tablelands) by Jurjens (1974) listed 502 species of which 37% were exotics. The similar proportions of exotic taxa found in Jurjens study and this recent survey suggest that the establishment of exotic species largely pre-dates 1974 and that there has been little change in relative proportions since that time. The study by White et al. (1990) around Chaffey Dam listed 328 species, of which 37% were exotic, which is comparable to the 43% found in our study of the northern side of Chaffey Dam (site 8). As a regional comparison detailed surveys of various sites in the Wagga Wagga district (South Western Slopes) of New South Wales, well to the south of this survey, indicate that the proportion of exotics in that area is around 28% (G. Burrows pers. comm.).

The relatively high number of exotic taxa recorded in the present study, particularly in the families Poaceae, Asteraceae and Fabaceae, reflects a long history of settlement and agriculture in the area including the widespread use of introduced grasses and legumes as pasture species. It may also reflect a high representation of disturbed sites. The area has a mix of winter and summer crops and their associated weeds. This has meant that introduced species have come from a range of climatic areas, from Mediterranean to sub-tropical.

The invasion of exotic species is closely associated with livestock grazing, soil disturbance, and reduction in cover of perennial species (McIntyre & Lavorel 1994, McIntyre et al. 1995, Pettit et al. 1995). This is reflected in the survey with the lowest percentage of exotic taxa recorded for Warrabah National Park (31%) while roadsides (site 7), grazing land (site 5) and the area around a tip (site 3) are close to 50%. The high proportion of exotic taxa in Oxley Park (47%) probably reflects the close proximity of Tamworth along the south-western boundary of the Park. Increasing use of Warrabah

National Park by campers and day visitors has also resulted in establishment of additional exotic species, particularly in the most heavily used areas. **Hyparrhenia hirta*, **Cenchrus incertus*, **Sporobolus africanus* var. *capensis*, **Centaurea melitensis* and **Richardia stellaris* are a few of the species that have established in the Park over recent years.

The threat of invasion and replacement of native species by introduced species is a serious problem. One species of particular concern is **Hyparrhenia hirta*, Coolatai Grass, which appears to be spreading and dominating many roadside areas. This species is difficult to control using herbicides and, if kept short and vegetative, appears to be a productive and palatable pasture species. In trials, **Hyparrhenia hirta* supported stocking rates of 20–37 dry sheep equivalents/ha over a 20-month period (Lodge et al. 1994). Two other species **Euphorbia davidii* and **Sida spinosa* appear to be increasing in roadside areas around Tamworth.

Taxa of conservation significance

(i) Rare or Threatened Australian Plants (ROTAP) and plants listed under the *Threatened Species Conservation Act (T.S.C. Act 1995)*

There are six species recorded within the study area currently listed as nationally Rare or Threatened Australian Plants (ROTAP) (Briggs & Leigh 1996): *Bothriochloa biloba* (3V), *Tylophora linearis* (3E), *Picris eichleri* (3KC-), *Hakea pulvinifera* (2ECi), *Derwentia arenaria* (3RC-) and *Euphrasia ruptura* (1X- *Euphrasia* sp. 1 [Tamworth] in Briggs & Leigh 1996). An additional species of state significance and listed as vulnerable under the Threatened Species Conservation Act (T.S.C. Act 1995) is *Dichanthium setosum* (*Bothriochloa biloba*, *Tylophora linearis*, *Hakea pulvinifera* and *Euphrasia ruptura* are also listed under the T.S.C. Act 1995). The grass *Bothriochloa biloba* has a relatively widespread distribution in northern New South Wales, however, it is generally uncommon and most of the records for the North Western Slopes (chiefly Warialda district) date back to the early to mid 1900s. Within the study area this species has been recorded from a roadside west of Duri (site 7), from black cracking clay soils, growing with another listed species *Dichanthium setosum*. This *Dichanthium* is also recorded from Attunga rubbish tip, Oxley Park and Chaffey Dam and is generally common within the study area. Other herbarium records for the North Western Slopes are pre-1940, the largest number of previous collections of this taxon being from the Northern Tablelands. *Tylophora linearis* (Asclepiadaceae) has been recorded from Crow Mountain (between Site 1 and Site 2 of Fig. 1). This species was not seen during this study and has not been included in Table 2 or the analyses. *Picris eichleri* (Asteraceae) has been recorded from three widely separated locations during this study. At Woodsreef many thousands of plants were present. These populations appear not to be adversely affected by grazing of the areas. All other herbarium records of this species are from the Northern Tablelands, many of which date back to the early 1900s with only one other recent record from Mount Kaputar National Park. This species may be more common, however, as it has been previously confused with **Picris hieracioides*. *Hakea pulvinifera* (Proteaceae) is restricted to a rocky hillside below Keepit Dam in Keepit State Recreation Area (Benson 1988). Although flowering

(Fig. 10), fruiting has not been observed in this population. *Derwentia arenaria* (Scrophulariaceae) was found growing over one ridge and neighbouring slopes in Warrabah National Park, with most other records for the North Western Slopes being from the Warrumbungle Ranges. Large populations of this species have recently been reported from within and outside Warrabah National Park (P. Davies pers. comm.) and this species is also known to occur further south at Mendooran and in the Goulburn River National Park (Central Western Slopes). *Euphrasia ruptura* (Scrophulariaceae) has only been recorded from the Tamworth area where it was collected by H.M.R. Rupp in 1904 but has not been collected since (Barker 1997). This species was not seen during this study and has not been included in Table 2 or the analyses.

(ii) Significant plants from serpentinite areas

The serpentinite areas at Woodsreef and east of Chaffey Dam are of particular interest with a high concentration of significant species including several undescribed taxa. New taxa of *Homopholis* (Poaceae), *Hovea* (Fabaceae) and *Callistemon* (Myrtaceae), currently being described, may warrant listing as ROTAPS and/or under the T.S.C. Act (1995) on further investigation. Undescribed species of *Dianella* (Phormiaceae), *Minuria* (Asteraceae) and *Glycine* (Fabaceae) may also be restricted to serpentinite areas. The dominant eucalypt at Woodsreef and east of Chaffey Dam, previously identified as *Eucalyptus macrorhyncha*, appears to be an undescribed species (J. Williams pers. comm.). *Boronia ruppii* is uncommon at Woodsreef, the type locality, and appears to be different to populations elsewhere in New South Wales (J. Williams

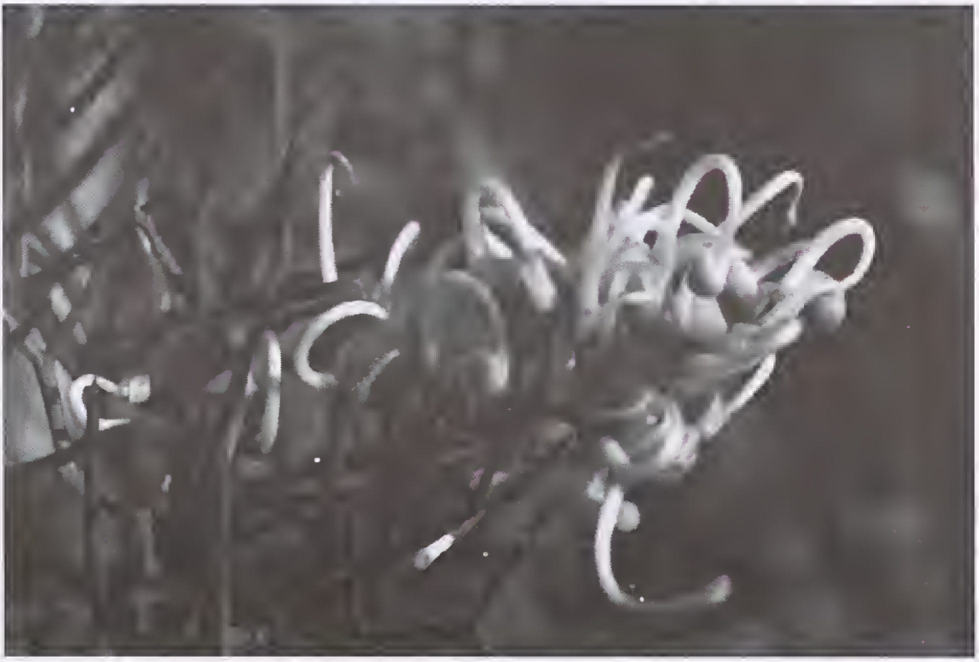

Fig. 10. *Hakea pulvinifera* — a rare shrub, growing near Lake Keepit.

and J. Bruhl pers. comm.). Another species growing on serpentinite that may prove to be unnamed is the *Brachyscome* occurring east of Chaffey Dam. This species has been identified as *Brachyscome rigidula* s. lat. (P. Short pers. comm.). According to Salkin et al. (1995) this species grows in alpine and sub-alpine areas in mainland Australia, areas very unlike the area east of Chaffey Dam.

The *Homopholis* sp. listed above is only known from around Woodsreef and another serpentinite area near Bingara (K. Wills pers. comm.). The *Hovea* sp. was previously only known from the Woodsreef area, however, it was also collected on serpentinite between Attunga and Halls Creek and east of Chaffey Dam during this study. The population east of Chaffey Dam appears to be the largest, while the population between Attunga and Moore Creek contains some individuals larger than any seen at other sites and this form requires further investigation. The *Callistemon* sp. common in gullies at Woodsreef has previously been confused with *Callistemon sieberi* (L. Craven pers. comm.) and was not found in any other area during this study. The *Dianella* sp., formerly confused with *Dianella revoluta* var. *vinosa*, was only found on serpentinite areas at Woodsreef and east of Chaffey Dam (G. Carr pers. comm.). *Minuria cunninghamii* in the National Herbarium of New South Wales (NSW) collection appears to contain two entities, one occurring on serpentinite at Woodsreef and east of Chaffey Dam and one from further west. The serpentinite form is clearly different from *Minuria cunninghamii* occurring in non-serpentinite areas (P. Short pers. comm.). Using current keys the *Glycine* sp. at Woodsreef and east of Chaffey Dam would key out to *Glycine clandestina* but the species from serpentinite is clearly different to the species elsewhere in the survey area. The *Glycine* found on serpentinite has longer hairs on the stems, leaves and calyces than the species occurring elsewhere in the survey area.

A recently described species, *Schoenus centralis* (Cyperaceae), has been recorded from serpentinite areas at Woodsreef growing specifically along intermittent creek beds, this species has variegated green and brown flowering heads, and is uncommon in northern New South Wales.

Further studies on serpentinite areas within this survey area appear to be warranted. None of the serpentinite species appears to be endangered by current grazing practices in the serpentinite areas mentioned above.

(iii) Plants of regional significance

Over 30 native taxa within the study area are considered to be of regional significance, most of which are new records for the North Western Slopes (see Table 2). These include disjunct populations of *Pterostylis chaetophora*, *Sida atherophora* and *Daphnandra* sp. A. Several species more common on the coast and tablelands reach their western limit within the study area including *Dendrobium cucumerinum*, *Dendrobium tarberi*, *Austrocynoglossum latifolium*, *Myriophyllum pedunculatum* subsp. *longibracteolatum*, *Melicope micrococca* and *Eucalyptus obliqua*. Western species reaching their eastern limit include *Bulbine alata* and *Cyperus pygmaeus*. The record of *Striga parviflora*, found growing amongst clumps of *Triodia scariosa* on serpentinite east of Chaffey Dam, is the first record of this root parasite from New South Wales.

Table 6. Number and proportions of native and naturalised exotic taxa in this study in relation to life form and life cycle.

	Total no. of taxa	No. of native taxa	% of native taxa	No. of exotic taxa	% of exotic taxa
Life form					
Fern (Pt)	16	16	100.0	0	0
Forb (F)	470	234	49.8	236	50.2
Grasses (G)	156	87	55.8	69	44.2
Grass-like (GL)	120	100	83.3	20	16.7
Low shrub (LS) (< 2m)	100	85	85	15	15.0
Tall shrub (TS) (> 2m)	51	34	66.6	17	33.3
Tree (T)	67	46	68.7	21	31.3
Climber or twiner (C)	38	23	60.5	15	39.5
Epiphyte (E)	7	7	100.0	0	0
Epilith (e)	7	7	100.0	0	0
Parasite (P)	16	15	93.8	1	6.2
Hemiparasite (HP)	2	2	100.0	0	0
Life cycle					
Annual (AN)	248	76	30.6	172	69.4
Short lived perennial (SP)	79	22	27.8	57	72.2
Perennial (PE)	672	519	77.2	153	22.8
Perennial rootstock and annual stems (PA)	42	30	71.4	12	28.6

(iv) Conservation reserves

The only conservation reserves existing in the survey area are found in dissected country on the eastern side, the largest being Warrabah National Park. Only one of the seven species of national and state significance (*Derwentia arenaria*) is currently in a conservation reserve within the study area. The Woodsreef site and the serpentinite area east of Chaffey Dam, in particular, warrant appropriate means of protection for their high concentration of significant species. Information presented in this study has been passed on to the NSW National Parks and Wildlife Service and they have expressed an interest in the Crown Land area around Woodsreef asbestos mine.

Life history attributes

A diversity of life forms (Table 6) is represented but overall the taxa are predominantly forbs, grasses or grass-like plants (72%) and a significant proportion are perennial (69%). The perennial taxa (perennials and plants with perennial rootstock and annual tops) are predominantly native (77%), whereas the annuals or short-lived perennials are predominantly exotic (70%). Similar results have been documented in other studies of Australian woodland and grassy communities (Trémont 1994, McIntyre et al. 1995, Pettit et al. 1995).

Conclusion

The native vegetation of the study area has been considerably altered since European settlement. Despite the long history of disturbance a relatively high number of native taxa are recorded (647), comprising 62% of the total number of taxa recorded. This species richness may reflect the diversity of landforms, geology and climate within the region as well as the natural resilience of many of the native species. The long-term nature of this study has provided a more complete picture of overall floristic diversity than generally found in shorter surveys. The threat of invasion and replacement by introduced species is a serious problem. The only conservation reserves existing in the survey area are found in dissected country on the eastern side, the largest being Warrabah National Park which recorded the highest number of native taxa (351). The authors know of no fertile, gently-sloping areas which have not been modified by many years of grazing or cropping. In these areas the least disturbed native vegetation is found along some stock routes and roadsides. The serpentinite areas at Woodsreef and east of Chaffey Dam are of particular scientific interest with an unusual concentration of rare, restricted and/or undescribed species and warrant further investigation and appropriate means of protection. A more comprehensive reserve system is clearly needed to protect the range of vegetation communities existing in the study area.

Acknowledgments

We would like to thank staff of the National Herbarium of NSW for identifying many of the specimens and also specialist staff at other herbaria. We would also like to thank Philip Christian, Ron Sippel, Karen Cassin and Debra Bayliss who mounted many of the specimens held at Tamworth. Permits to collect in National Parks and State Forests were arranged by Australian National Botanic Gardens herbarium staff (now part of CANB) and permission to collect around Chaffey Dam was given by Stuart Johnson (Department of Water Resources). A number of property owners are to be thanked for allowing collections to be made on their properties, in particular John McManus who owned site 5, and Cecil Tongue who owns 'Taroona' where a number of the collections listed as Eh were made. We thank Barry Conn, Richard Groves, Royce Holtkamp, Surrey Jacobs, Greg Lodge, Bob Martin, Wal Whalley and referees for making useful comments on the manuscript.

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Manuscript accepted 8 May 1998

Bee pollination in the threatened Australian shrub *Senna acclinis* (Caesalpinioideae)

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Williams, G. (c/o Entomology Department, The Australian Museum, 6 College Street, Sydney, NSW, Australia 2000) 1998. Bee pollination in the threatened Australian shrub Senna acclinis *(Caesalpinioideae).* Cunninghamia *5(3): 767–772. Senna acclinis* is a gap-phase shrub primarily restricted to subtropical rainforest remnants in coastal New South Wales and Queensland. The species has declined due to clearing of habitat. Aspects of the reproductive ecology of *Senna acclinis* were studied in a small population in littoral rainforest on the NSW north coast. *Senna acclinis* was found to be pollinated by a taxonomically diverse assemblage of generalist native bees. Three of these, *Amphylaeus nubilosellus*, *Hylaeus turgicollaris* and *Lasioglossum polygoni*, were observed to buzz pollinate flowers.

Although apparently self-compatible, the anthers do not readily release pollen unless vibrated. Conservation of remaining *Senna acclinis* populations may be dependent on the availability of a pool of pollinators capable of releasing pollen from the poricidal anthers, the elimination of exotic *Senna* species from rainforest remnants, and the presence of appropriate microhabitats such as canopy gaps and sunlit margins.

Introduction

The genus *Senna* (family Fabaceae, subfamily Caesalpinioideae) worldwide comprises approximately 350 species of shrubs and herbs (Harden 1991). Fifteen species are recorded from New South Wales but six of these are exotic species, introduced from the Americas and Africa (Harden 1991), that have become naturalised to varying degrees.

Senna acclinis (F. Muell.) Randell is a native shrub restricted to the central and northern coastal forests of New South Wales, and Queensland. In New South Wales it is chiefly recorded from subtropical rainforest remnants but is now rare owing to clearing of habitats (Harden 1991). *Senna acclinis* is listed as endangered on Schedule 1 of the New South Wales *Threatened Species Conservation Act 1995*, and has a 3RC- ROTAP (Rare or Threatened Australian Plants) status (Briggs & Leigh 1995). Although the reproductive ecology of a number of foreign Caesalpinioideae has been studied (e.g. Silander 1978, Dulberger 1981, Dulberger & Bawa 1994) that of *Senna acclinis* has not been described previously. The aims of this paper are to provide information on the reproductive ecology of *Senna acclinis* and to supplement information currently available for the formulation of management strategies.

Methods and Results

A small clump (approximately 5 × 3 m) containing 14 mature *Senna acclinis* plants was studied during 1996–97 in littoral rainforest at Hallidays Point (32°04'30"S, 152°32'45"E) on the north coast of New South Wales. These plants constituted the majority of known mature plants at this locality. *Senna acclinis* growing and flowering at the study site were restricted to small disturbed openings in the canopy. Seedlings grow below mature plants but neither seedlings nor mature plants were located in undisturbed shaded rainforest understorey elsewhere at the site, suggesting that *Senna acclinis* is a gap-phase species. Visitors to flowers were observed on three occasions in 1996 during daylight. Insects were the only flower visitors observed, but only species that came into contact with the stigma or stamens were considered potential pollinators. Voucher insect specimens were collected for later identification and examination of pollen loads (Table 1). Small native bees, in particular, are very difficult to identify in the field and the need to collect some individuals for identification and reference was unavoidable. Pollen isolated from flower visitors was compared with *Senna acclinis* pollen to determine foraging constancy.

Table 1 Pollen loads on insects visiting *Senna acclinis* flowers (n/a = no apparent pollen; number of foreign pollen species in brackets; 'home' pollen = *Senna* pollen).

Taxa	**voucher no.**	**% 'home' pollen**	**sites of pollen lodgement**
Amphylaeus nubilosellus	1	100	vertex, hind femora, abdominal
	2	71 (1)	ventrites, scattered grains on body
	3	> 90(1–2)	surface generally
	4–8	n/a	
Hylaeus turgicollaris	1	100	foretibia, thorax
	2–3	n/a	
Lasioglossum polygoni	1	100	ventrites 1–2, hind femora
	2	> 99 (1–2)	and tibiae, thorax generally, base
	3	100	of wings, fore, mid and hind leg
	4	~ 60 (1)	
Lasioglossum victoriellum	1	> 95(1)	frons, ventrites 1–2, hind legs
Lasioglossum sp.	1	> 95(1–2)	ventrites 1–6, hind legs
	2	100	
Exoneura sp.	1	100	hind legs, ventrite 1, ventral
	2	100	surface generally
Myrmecia nigrocincta	1	100	mesotibia, mid trochanter mesepisternum
Phanagenia ?fasciata	1	n/a	

Senna acclinis flowers are bisexual but at least partly protogynous; yellow in colour; approximately 30 mm wide at full anthesis (in female-phase flowers the corolla is only partly open and the stigma abuts the anthers; in male-phase flowers the corolla is fully open); lightly but sweetly fragrant; style long, falcate, narrowly tapered to apex, pale green; stigma lighter creamy green, turning brownish in colour and recurving away from anthers when no longer receptive; stamens usually 10; immature anthers approximately same colour as corolla, ochre in colour when pollen is mature and able to be displaced; anthers dehiscent longitudinally along central suture but pollen does not readily dehisce unless stamens are vibrated (= 'buzz' or vibratile dehiscence); pollen not strongly sculptured. Flowers do not possess obvious nectar rewards or nectariferous glands; most buzz pollinated angiosperms offer pollen as the only reward (Buchmann 1983). There is no depth effect in the corolla, consequently floral morphology does not limit visitor access but the poricidal anthers restrict access to pollen.

To exclude visitors and determine the potential of flowers to self-fertilise, 55 unopened flower buds on four plants were covered with fine nylon fabric bags (29 October 1996). Bags were removed on 20 December 1996 when all flowers in bagged inflorescences had abscissed. No fruit had developed from bagged flowers. An additional 16 flowers were similarly bagged in mid-December 1997, and anthers on nine of these were vibrated by hand using a tuning fork (A). Vibration resulted in displacement of pollen, as a distinct cloud, from mature anthers. Although pollen clouds appeared to envelope individual stigmas no fruit developed and all bagged flowers abscissed. However, it was difficult to time field visits to coincide with maturation of anthers and so the absence of developing pods from vibrated flowers may be due to flaws in the methodology. In addition, a single *Senna acclinis* plant (18 months old; < 25 cm in height), held in an open nursery shadehouse at Lorien Wildlife Refuge, Lansdowne near Taree, flowered on 25 December 1997 (despite extensive field traverses of the region no other populations of *Senna acclinis* are known within a 25 km radius of this location). The flowers were left unbagged and were accessible to native bees from adjacent riparian subtropical rainforest and wet sclerophyll forest (see Williams & Adam 1997 for species list). Of the three flowers produced, two set fruit (pod 1 = 17 seeds, pod 2 = 21 seeds; of which 7 germinated), indicating that the species is self-compatible, but that unvibrated anthers retain pollen and this acts as a barrier to self-fertilisation.

Visitors to flowers of all 14 mature plants in the clump at Hallidays Point were observed between 1230–1400 hours (E.S.T.) on 26 October 1996 and between 0958-1410 hours on 29 October 1996. Casual observations were also undertaken on 20 December 1996 (no observations were undertaken on the nursery specimen held at Lorien Wildlife Refuge). Species visiting flowers are listed in Table 1.

Six bee species, *Hylaeus turgicollaris* Michener, *Amphylaeus nubilosellus* (Cockerell) (Colletidae-Hylaeinae), *Lasioglossum polygoni* (Cockerell), *Lasioglossum victoriellum* (Cockerell), *Lasioglossum* (*Parasphecodes*) sp. (Halictidae), and *Exoneura* sp. (Anthophoridae), visited *Senna acclinis* plants in the clump. All species carried *Senna acclinis* pollen (Table 1) but only one of the three *Hylaeus turgicollaris* specimens collected carried pollen (4 grains) (Table 1). *Hylaeus turgicollaris* was previously only recorded from the type locality, Jamberoo, approximately 300 km to the south (Cardale 1993). *Lasioglossum polygoni, Lasioglossum victoriellum, Lasioglossum* (*Parasphecodes*) sp. and *Exoneura* sp. carried large quantities of pollen principally massed on the sternum (ventral metasoma) and hind femora and tibiae. Exotic honey bees *Apis mellifera* Linn. were common at the site and although recruiting to adjoining mass-flowering *Guioa semiglauca* (F. Muell.) Radlk. (Sapindaceae) trees in the rainforest canopy were not observed visiting *Senna acclinis* flowers. This may be because *Senna acclinis* does not appear to offer nectar rewards and pollen does not readily dehisce from anthers.

Other insects observed visiting flowers were the large myrmecine ant *Myrmecia nigrocincta* Smith and a pompilid wasp *Phanagenia ?fasciata* Fab. No pollen was isolated from the wasp. *Myrmecia nigrocincta* commonly forages for nectar from numerous flowering trees and shrubs in subtropical rainforest (Williams 1993, 1995). The ability of ants to function as pollinators has been widely debated (reviewed in Williams & Adam 1994) and is dependent upon the nature of the plant breeding system, plant morphology or chemical defenses that deter ant visits, limitations imposed by ant foraging patterns, and the presence and function of ant metapleural gland secretions, which may be toxic to pollen. The ability of *Myrmecia nigrocincta* to function as a pollinator has not been studied but Peakall et al. (1987) have recorded *Myrmecia urens* Lowne pollinating the orchid *Leporella fimbricata* (Lindl.) George. In this example, however, *Myrmecia urens* transported orchid pollinia rather than pollen grains. *Myrmecia nigrocincta* foraged progressively on adjoining plants at Hallidays Point without returning to their nest site between visits to individual plants. Although *Senna acclinis* is apparently self-compatible the inability of *Myrmecia nigrocincta* to appropriately release pollen would restrict its capacity to effect pollination.

In addition to general observations, visitation rates (frequency) by potential pollinators were investigated on two closely adjoining plants (1.5–2 m in height), in the same clump, between 1000–1410 hours on 29 October 1996. Plants were partly shaded when observations commenced and remained largely in partial sunlight throughout this time. The only insect visiting flowers on the two plants during this period was the native bee *Amphylaeus nubilosellus*. Eight voucher specimens were collected, three of which carried *Senna acclinis* pollen (Table 1). Collectively, there were 37 *Amphylaeus nubilosellus* visits during the 4 hours of observation with the plants averaging 1 bee visit every 7 minutes. Individual flowers were often revisited, however, the time between bee visits to flowers ranged from < 1–48 minutes. Time spent foraging at individual flowers ranged from < 1 minute to > 12 minutes. Flowers in full sunlight generally received frequent visits and many shaded flowers were not visited during the period of observation.

Three bees *Amphylaeus nubilosellus*, *Hylaeus turgicollaris* and *Lasioglossum polygoni* frequently (but not always) removed pollen from dehiscent anthers by landing on stamens and then vibrating anthers by 'buzzing' their flight muscles. The duration of individual buzzing events was generally less than 2 seconds but the sound was audible over a distance of at least 1 m and was often the only indication that bees were present at flowers. In addition to bees being potentially dusted with pollen, buzz removal of pollen resulted in pollen deposition on the inner surfaces of petals directly below the anthers, and this pollen may become available for transport by other flower visitors. All three bees collected the pollen from the petal surfaces, so that in effect the petals functioned as secondary pollen presenters. After collecting pollen *Amphylaeus* *nubilosellus* and *Hylaeus turgicollaris* frequently rested on sunlit leaves and groomed their bodies. Hylaeinae carry pollen in their crop but small amounts of pollen were isolated from the body surfaces of both species (Table 1). That bees would groom following visits to previously 'buzzed' flowers, indicated that single bee visits resulted in partial removal of pollen only. Harder & Barclay (1994) suggest that restricted removal of pollen from flowers with poricidal anthers encourages pollen transport by greater numbers of pollinators and, in turn, acts to promote successful pollen dispersal.

Discussion

Buzz collection of pollen has been recorded in numerous bee taxa (Roubik 1989), including several Australian species (Houston & Thorp 1984, Gross 1993). Gross (1993) observed that anthophorid and halictid bees in tropical Queensland buzz collected pollen from the pioneer shrub *Melastoma affine* D. Don. (Melastomataceae), which has poricidal anthers and thus requires buzz pollination. As with the three species recorded buzz collecting pollen from *Senna acclinis*, the bees observed by Gross, capable of buzz collecting pollen from *Melastoma affine*, did not always buzz anthers.

Although *Senna acclinis* appears to be self-compatible it is dependent on a pool of pollinators capable of removing the generally indehiscent pollen. The bees recorded visiting *Senna acclinis* are generalists (though they may exhibit temporal or spatial foraging constancy to individual flowering species) and have been recorded from other plant taxa (Cardale 1993, Williams 1993, 1995, Williams & Adam 1997). The ability of *Senna acclinis* to recruit pollinators from a pool of bees that are generalist foragers, rather than being dependent upon a single pollinator, may reduce the vulnerability of *Senna acclinis* populations to local extinction. The study site is the subject of a community-based rainforest regeneration project but exotic *Senna pendula* (Willd.) Irwin & Barneby, and less commonly *Senna* × *floribunda* (Cav.) Irwin & Barneby, infest the rainforest margins (P. Muggeridge pers. comm.). Although the exotic species did not flower concomitantly during this study, an overlap in flowering phenology at this site, or elsewhere with other disjunct *Senna acclinis* populations, may impact on the pollination ecology of surviving *Senna acclinis* populations. Bond et al. (1991) record that invading Australian *Acacia* species have 'parasitised' dispersal mutualisms in Cape fynbos vegetation of Southern Africa. *Senna acclinis* seed dispersal mutualisms were not investigated but the dry seeds, though not possessing ant-attracting elaiosomes, have a small peripheral indentation that could facilitate dispersal by ants. Ants are unlikely to disperse seeds over large distances but they potentially disperse seeds to microsites that are advantageous for germination and seedling recruitment (Horvitz 1991).

Conservation action plans aimed at preserving *Senna acclinis* populations need to address possible impacts to plant reproductive ecology posed by sympatric populations of exotic *Senna* species. In addition it may be necessary to artificially manipulate the availability of canopy gaps so that *Senna acclinis* seedlings can continue to recruit within the rainforest community.

Acknowledgments

I thank Dr Terry Houston (Western Australian Museum, Perth) and Dr Ken Walker (Museum of Victoria, Abbotsford) for identifying the bees, and Dr Pam Muggeridge (Hallidays Point Landcare Group) for site information. Dr Ken Walker, Prof. Paul Adam (University of New South Wales), Dr David W. Roubik (Smithsonian Tropical Research Institute, Panama), and one anonymous referee are also thanked for comments on the manuscript. Mr Graham Wilson (Threatened Species Unit, NSW. National Parks & Wildlife Service, Sydney) and Mr Terry Evans (Greater Taree City Council) kindly provided information on the conservation status of *Senna acclinis*.

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Manuscript accepted 14 July 1998

SHORT COMMUNICATION

Ecology and conservation status of *Muehlenbeckia tuggeranong* (Polygonaceae) near Canberra

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Introduction

Muehlenbeckia tuggeranong Mallinson (Family Polygonaceae) discovered in 1997, is known from one population of seven plants near Canberra, and should be provisionally regarded as highly endangered. Habitat is described, threat processes identified, and recommendations are made for conservation priority codings and management actions.

Biology

Plant form: *Muehlenbeckia tuggeranong* is a procumbent or sprawling, scarcely woody subshrub, eventually becoming a loose tangled mound of wiry stems, up to 1 m high and 1–2 m across. Leaves are alternate, with laminae oblong to elliptical or almost violin-shaped, 5–13 mm long by 2–4 mm wide. Flowers are inconspicuous, 4–5 mm diam., usually in lax terminal spikes 5–20 mm long. Fruits are trigonous nuts c. 3 mm long. A full description and discussion of affinities are given in Makinson & Mallinson (1997).

Reproduction: Flowering has been observed from December to late February. Pollination vectors are unknown and it is not yet clear whether any effective pollination is occurring at the site. No fully mature fruits have been found over two (dry) summers, and no seedlings have been observed. The breeding system of the plant is unknown, although post-disturbance (often post-fire) explosive recruitment in some other species of *Muehlenbeckia* (Hunter et al., 1998; R. Makinson pers. comm.) does suggest that features of the genus include a tolerance to cyclic in-breeding and/or a long dormancy of propagules in the soil seed-bank. Dioecy is the general rule in the genus, although occasional monoecy has been observed (Wilson, 1990: 284). One male plant of *Muehlenbeckia tuggeranong* is doubtfully hermaphrodite, having fertile anthers and (in 1997) some swollen ovaries, but functional hermaphroditism is not confirmed. Growth rates are unknown, but likely to be slow. Cultivated material has shown an ability to root-sucker, but neither root-suckering nor rhizotomy have yet been confirmed in the field. The known population comprises six males and one female.

Disease: Leaf-galls are present on some plants, causing reddish swellings and distortion of the leaf blade. The galls are up to several millimetres in diameter. The causative agent has been identified as a mite of the family Eriophyidae (M. Colloff, pers. comm.). Further work by one of us (Stadler) suggests that this is an undescribed species. The microscopic mites are found in clusters inside the galls. Similar galls occur in most populations of *Muehlenbeckia axillaris* (R. Makinson, pers. comm.). The galls persist on *Muehlenbeckia tuggeranong* in cultivation.

Habitat

Distribution: *Muehlenbeckia tuggeranong* occurs immediately south west of Canberra, in the Australian Capital Territory, in the New South Wales Southern Tablelands botanical subdivision (sensu Anderson, 1961), part of the South Eastern Highlands IBRA region (Thackway & Cresswell, 1995). It grows along the Murrumbidgee River, where it is as yet only known from the Pine Island area in the Murrumbidgee Corridor Nature Reserve. Only seven plants of the species are known, all from a riparian association on the eastern bank of the river at an altitude of c. 560 m.

Landform, geology and substrates: The plants occur on river bank terraces prone to occasional flooding, and on an adjacent gentle slope. This section of the river is typified by rapids, sand reaches and boulders, with uneven rocky flood terraces, some up to c. 100 m wide, at 2–8 m above normal river level. Downstream of Pine Island the river forms rugged gorges. The higher surrounding terrain is gently sloping, open and undulating.

The underlying geology (1: 100 000 geological map; BMR/AGSO sheet Canberra 8727) is rhyodacitic ignimbrite of the Silurian Laidlow Volcanic Suite. This formation outcrops along the Murrumbidgee River from Tharwa to a few kilometres downstream of Kambah Pool and encompasses the whole study site. It includes small occurrences of volcaniclastic and marine epiclastic sediments.

Muehlenbeckia tuggeranong grows in medium to coarse-textured alluvium, mainly quartzitic sand and gravel, with local richer pockets of silty sand soil. Soils around all plants have a low organic content. The species also grows in crevices amongst larger rock outcrops.

Climate: The Canberra area experiences annual average temperature ranges of 6.3°C minimum and 19.4°C maximum, and a mean annual rainfall of 631 mm (Canberra Airport Climatological Data 1996 — some kilometres from Pine Island). Frosts are common between April and November, with temperatures occasionally down to 10°C.

Associated vegetation: *Muehlenbeckia tuggeranong* is found in a disturbed riparian shrub and woodland association, heavily invaded by exotic weeds. The patchy, open tree layer comprises remnant native species and introduced willows. Understorey varies from densely vegetated to open with scattered grasses and shrubs, with areas of bare rock and sand. *Muehlenbeckia tuggeranong* is found both in exposed situations in crevices on nearly bare rock, or tangled amongst other vegetation.

Associated species (* indicating introduced taxa) include *Casuarina cunninghamiana* Miq. subsp *cunninghamiana, Kunzea ericoides* (A.Rich.) J.Thompson, *Acacia dealbata* Link, *Grevillea juniperina* R.Br. *subsp. nov.* (known as the 'Canberra form'), **Salix alba* L., *Lythrum salicaria* L., **Rosa rubiginosa* L., **Verbascum thapsus* L., **Oenothera* sp., **Echium vulgare* L., **Foeniculum vulgare* Miller, **Plantago lanceolata* L., **Rumex crispus* L., **Hypericum perforatum* L., **Hypochaeris radicata* L., *Typha domingensis* Pers., **Cyperus eragrostis* Vahl, *Isolepis* sp., *Poa labillardierei* Steudel, *Notodanthonia racemosa* (R.Br.) Zotov var. *racemosa, Dichelachne micrantha* (Cav.) Domin, **Phalaris aquatica* L., *Phragmites australis* (Cav.) Steudel, **Eragrostis curvula* Nees, **Holcus lanatus* L., **Cynodon dactylon* (L.) Pers. **Rubus* spp. (Blackberry) also occurs nearby.

Flood regime: The site is prone to occasional inundation by major floods, although seasonal snow-melt inflows to the river have been reduced since the building of Tantangara Dam in the 1950s. The last flood to have inundated levels on which at least three of the known plants occur was in 1991. The sole female plant was probably inundated by a smaller flood in 1994 (J. Bros, pers. comm.). The plants are situated 1.5–8 m above normal summer river levels.

Fire regime: The general area was reportedly subject to frequent fire-hazard reduction burns for many years until about 1987 (L. Margules, pers. comm.). Small-scale managed burns of *Phragmites australis* stands in the riparian zone are still carried out in winter. Wildfire, mostly anthropogenic, has also occurred frequently, but is seldom of high intensity and rarely reaches the current *Muehlenbeckia tuggeranong* habitat (J. Bros, pers. comm.).

Comparison with habitat of *Muehlenbeckia axillaris*: The closely related *Muehlenbeckia axillaris* occurs in the Northern and Southern Tablelands botanical subdivisions of New South Wales, and in Victoria, Tasmania and New Zealand. In mainland Australia, *Muehlenbeckia axillaris* occurs at higher altitudes, the nearest known location being near Googong Reservoir at 680 m a.s.l., but elsewhere in New South Wales at 770–1200 m. *Muehlenbeckia axillaris* has similar habitat preferences to *Muehlenbeckia tuggeranong*, growing on damp rocky slopes and river flood terraces, where it can be found exposed or matted amongst other plants.

Conservation

Population status and threat processes: The population comprises seven plants (one female, six male) scattered over c. 1.2 km of riverside. No other populations are known, despite searches by us and others over much of the Murrumbidgee Corridor Reserve system from the Angle Crossing area (Gigerline Nature Reserve) to 2 km below Kambah Pool. Searches included higher, drier slopes, some of which retain substantially intact native vegetation. The plant is easily overlooked, but is clearly very rare in the area of occurrence.

The riverside habitat is much disturbed, by flooding and by human impacts (grazing, weeds, altered fire and flood regimes). There is much apparently suitable habitat, seemingly with many opportunities for establishment and growth. The paucity of plants found suggests natural rarity, although large population fluctuations may be possible. Using Rabinowitz's (1981) seven types of rarity, *Muehlenbeckia tuggeranong* can be provisionally classified as 'constantly sparse and geographically restricted to a specific habitat'.

Five individuals are under possible threat from competing vegetation. The naturalised weeds **Hypericum perforatum* (St. John's Wort) and **Eragrostis curvula* (African Love Grass) are abundant and highly aggressive. The native shrub *Kunzea ericoides* (Burgan) and the reed *Phragmites australis* (Common Reed) are closely associated with at least three plants and may outcompete or outshade them. Others of concern include **Rubus* spp. (Blackberry species) and **Salix* spp. (Willow species).

Agricultural grazing poses no current problem as it has not occured on site for at least 23 years (J. Bros, pers. comm.). Sheep grazing occurs on neighbouring properties abutting the corridor reserve, but *Muehlenbeckia tuggeranong* has not been sighted at these drier sites away from the river. Herbivores such as grey kangaroos, hares and rabbits are present in the reserve area, but it is not known whether they feed upon the *Muehlenbeckia*; no obvious signs of browsing have been observed.

Some effects of floods such as substrate disturbance and debris deposition may constitute a threat process to individuals, and given the tiny size of the population may constitute a major stochastic threat to the species. Nevertheless, periodic disturbance may also be beneficial in providing more opportunities for establishment of propagules.

The habitat is adjacent to a developed and intensively used recreation area. About 80 000 vehicles and 190 000 people visit Pine Island annually (J. Bros, pers. comm.). Associated risks include trampling (especially a problem for the only known female plant, which is located on an informal foot-track), further clearing or track development, soil compaction, and deliberate or accidental fire. Some modification of drainage due to establishment of roads, car parks and picnic areas has clearly occurred, although impact on the species is not known. Potential chemical contamination of parts of the habitat through motor oil and fuel runoff is of some minor concern, and increased nutrient inputs, including reported occasional overflows from nearby toilet blocks (D. Dempster, pers. comm.) may encourage growth of competing weeds.

Weed invasion and weed control methods are both potential problems. Exotic and native species of particular concern are noted above. The ACT Parks & Conservation Service have conducted spraying and slashing of weed species in the area, particularly **Rosa rubiginosa* (Sweet Briar), **Rubus* spp. (Blackberry) and **Hypericum perforatum* (St John's Wort). Most chemical weeding has been on the margins of mown areas and toilet blocks, but some has been closer to the river in areas near the *Muehlenbeckia*. Applications of glyphosate ('Round-up') and metsulfuron methyl ('Brush-off') were conducted in October 1996. Chemical weed management has increased in recent years as part of more intense management of the area. Accidental application of herbicide is a potential direct threat to *Muehlenbeckia tuggeranong*, but management of competing vegetation is probably essential to the survival of the few known plants.

Ex-situ propagation: Cutting material from five plants was taken in early 1997 for propagation at the Australian National Botanic Gardens, Canberra. Nine punnets of cuttings were divided among three different hormone treatments (2000 mg/l potassium-based indole butyric acid, 4000 mg/l gel-based indole butyric acid, 1600/1600 mg/l ethanol-based indole butyric acid, all carried in naphthalene and acetic acid), and a total of 109 cuttings processed. Standard propagation mix of five parts perlite and one part peat was used as the striking medium. Most cuttings carried galls of the eryiophid mite.

Propagation of the female plant with the potassium-based hormone proved most effective, with a 75% strike rate; the other two hormone treatments each yielded a 42% strike rate. Male plant cuttings propagated slightly later yielded a 33% strike rate with the gel-based hormone, whilst the other two both gave a 53% strike rate. It should be noted that a control set (no hormone teatment) was not used, and environmental conditions were not rigorously standardised.

Struck plants remain healthy at July 1998, with no obvious adverse effects from the eriophyd gall infestations, which remain present. Some plants have been seen to sucker from the bottom of the pot. The five clonal lines struck are being maintained in the permanent collection, and 30–40 plants (including females) have been planted out at the ANBG.

Conservation coding: Further searches of likely habitat are essential before a final rarity and threat status can be decided. The small size of the known population and its very restricted geographic extent make it very vulnerable to stochastic events.

Under the ROTAP criteria (Briggs & Leigh, 1996) an interim and precautionary conservation coding of 2ECt is recommended (where 2 = small population with geographical range of less than 100 km; E = endangered; C = present in a conservation reserve and t = total known population reserved). Under the IUCN Red List criteria (IUCN, 1994), the species qualifies for a coding of CR (Critically Endangered), satisfying criteria B and B1 (area of occupancy < 10 km^2, single location), arguably C2 (projected decline, single subpopulation), and D (< 50 individuals). No data are available on actual population dynamics, to assess against other criteria, and to date no quantitative analysis has been performed as to probablity of extinction (criterion E).

Management recommendations: Serious threats to *Muehlenbeckia tuggeranong* include weed competition, herbicide poisoning, and human physical impact (trampling and other forms of damage). Of lesser concern are herbivory, and factors associated with runoff from developed areas. The tiny population size, and apparent lack of recruitment, make the species highly vulnerable, even to stochastic extinction through processes (such as fire and flood) that may in other respects be beneficial. Conservation efforts must address these issues and provide protection within reason.

Further control of competing plants, especially exotics, is needed. Alternative methods to herbicide spraying, such as cut and dab and mechanical removal, should be employed in the vicinity of *Muehlenbeckia* plants, to reduce the risk of spray drift.

Human impact will always be a problem for *Muehlenbeckia tuggeranong* at this site, as Pine Island is a popular recreational area. Public relations, education and protective fencing should be considered as management options.

A monitoring and recovery plan is needed. This should include as an urgent priority further intensive surveys of the middle reaches of the Murrumbidgee R. from the Bredbo area downstream to Burrinjuck Reservoir, and especially along the stretches of river bounded to the west by the Clear and Bullen Ranges. If surveys confirm the rarity of the species, a research program should be developed to analyse genetic variability, breeding system, and response to disturbance. The species and its closest congener are ideally situated for development of local university projects in concert with a recovery plan. Subject to the survey outcomes, further precautionary ex-situ propagation is desirable, and depending on research outcomes enhancement planting back into the wild may eventually be justified.

Acknowledgments

The assistance of Bob Makinson and Andrew Lyne, both of the Australian National Herbarium (CANB), with the conduct of fieldwork and the writing of this paper, is gratefully acknowledged. We would also like to thank the following people for information and/or assistance with field work: Faye Davies, Judith Curnow, and Anthony Whalen (all of CANB); Kim Pullen and Mathew Colloff (CSIRO Division of Entomology, Canberra); Jules Bros, David Dempster, Peter Ormay and Darren Russo (all of the A.C.T. Parks & Conservation Service); Lou Margules (formerly of the ACTP & CS); Joe McAuliffe and other staff of the Nursery and Plant Records Units at the Australian National Botanic Gardens; and Graham Taylor (University of Canberra).

This project was conducted as part of the 1997 Student Botanical Interns Program of the Australian National Herbarium, Canberra.

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Manuscript accepted 20 July 1998

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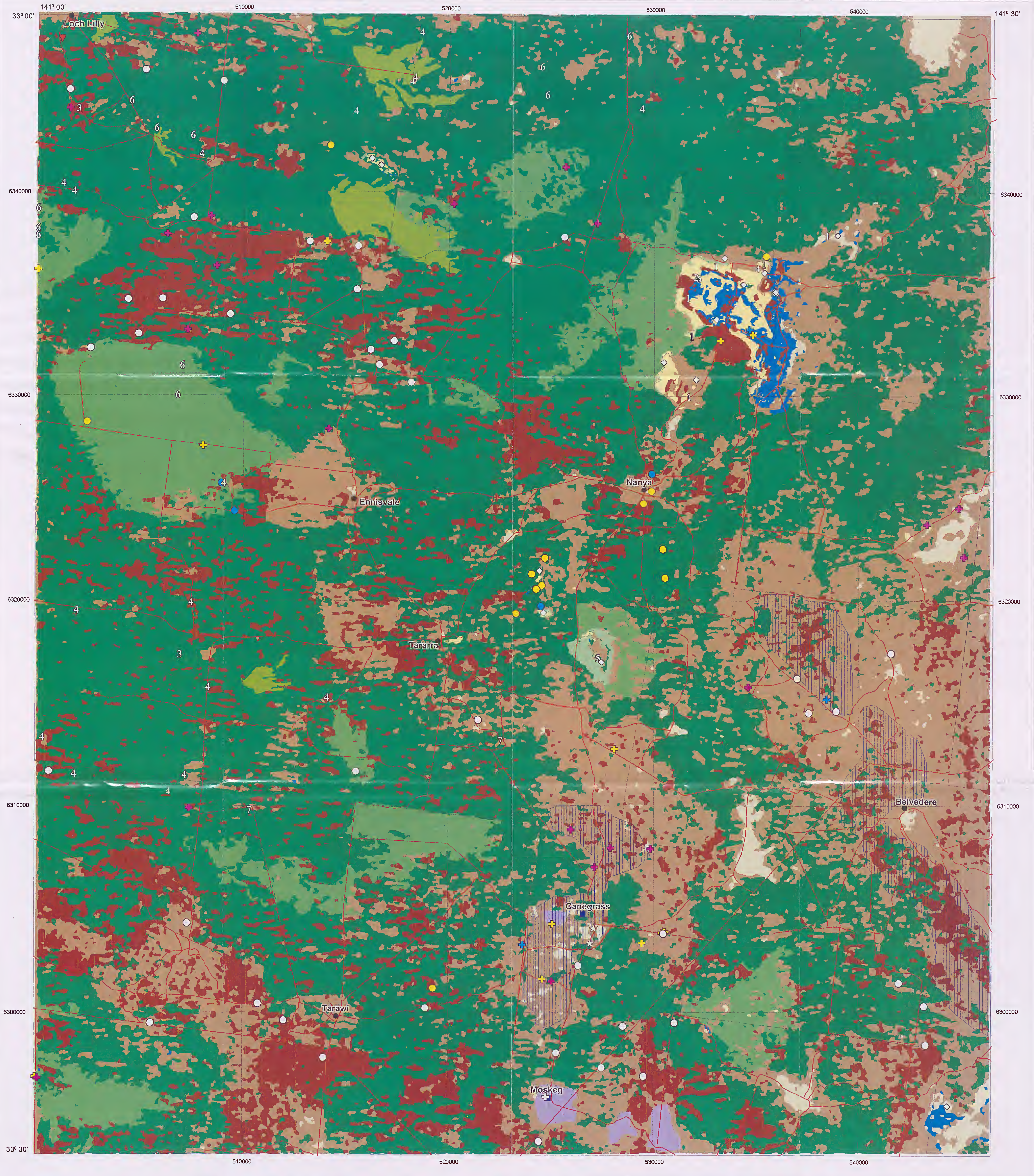

VEGETATION
# of the
SCOTIA 1:100 000
MAP SHEET
Western
New South Wales

M.E. Westbrooke, J.D. Miller & M.K.C. Kerr

Centre for Environmental Management,
University of Ballarat.
To accompany
CUNNINGHAMIA VOLUME 5 NUMBER 3, 1998
Royal Botanic Gardens Sydney

A MAPPED UNITS

COMMUNITIES REPRESENTED BY SYMBOLS
ARE TOO SMALL TO BE MAPPED AT THIS SCALE.

	1	**Woodlands**
🟥	1a	Woodland dominated by Casuarina pauper frequently associated with Alectryon oleifolius subsp. canescens and/or Myoporum platycarpum. Understorey includes Enchylaena tomentosa, Chenopodium curvispicatum, Maireana pentatropis and Eremophila sturtii.
✚	1b	Eucalyptus largiflorens open-woodland.
✚	1c	Callitris glaucophylla open-woodland.
✚	1d	Hakea leucoptera low open-woodland.
✚	1e	Hakea tephrosperma low open-woodland.
▥		Casuarina pauper woodland/open-woodland in which Geijera parviflora may be an associate.
	2	**Eucalypt shrublands (Mallee)**
🟩	2a	Eucalyptus open-shrubland of E. oleosa, E. gracilis and E. dumosa. Associated shrubs include Enchylaena tomentosa, Chenopodium curvispicatum, C. desertorum, Maireana pentatropis, Eremophila sturtii, Olearia muelleri and Senna artemisioides.
🟩	2b	Eucalyptus open-shrubland of E. gracilis with Melaleuca lanceolata associated.
🟩	2c	Eucalyptus open-shrubland of E. socialis, E. dumosa and E. gracilis with Triodia scariosa as the dominant component of the understorey. E. oleosa, E. incrassata and E. leptophylla are occasional associates. Sparse shrub layer.
☆	2d	Eucalyptus porosa low open-woodland.
🟩		Eucalyptus spp. open-shrubland that burned between 1975 and 1995.
🟩		Eucalyptus spp. open-shrubland that burned in December 1996.
	3	**Acacia shrublands**
●	3a	Acacia aneura open-shrubland
●	3a	Acacia loderi open-shrubland
	4	**Low open-shrublands**
🟫	4a	Areas of mixed shrubland with or without a sparse woodland or Eucalyptus spp. overstorey. Much of this map unit is presumed to be a result of past disturbance including chaining.
🟪	4b	Low open-shrubland of Maireana sedifolia.
○	4b	Woodland and shrubland with understorey dominated by Maireana sedifolia.
🟦	4c	Low open-shrubland of Atriplex vesicaria. Frequently associated species include Lycium australe, Disphyma crassifolium, Maireana pentatropis, Scleroleana obliquicuspis and Stipa spp.
🟨	4d	Low open-shrubland dominated by Halosarcia spp., Frankenia spp. and Osteocarpum acropterum.
◇	4e	Halosarcia lylei low open-shrubland.
	5	**Grasslands/Herblands**
▼	5a	Eragrostis australasica grassland.
⬜	5b	Areas of largely exotic grasses and herbs with no associated shrubs generally occurring around the more reliable groundwater tanks.

B LOCATIONS OF SIGNIFICANT SPECIES

Species not previously recorded for NSW

1	1	Hemichroa diandra
2	2	Elachanthus glaber
3	3	Podotheca angustifolia

**Species with restricted distribution
in western NSW
or not previously recorded for SFWP
(Harden 1990-93)**

4	4	Cratystylis conocephala
5	5	Kippistia suaedifolia
6	6	Acacia acanthoclada
7	7	Bergia trimera

∿	Road/track
∿	Property boundary
●	Homestead
■	Earth tank

N
W E
S

0 5 10 Kilometres

SCALE 1:100 000

Horizontal Datum: Australian Geodetic Datum 1966
Transverse Mercator Projection: Australian Map Grid Zone 54

Grid lines are 10 000 metre intervals of the Australian Map Grid, Zone 54.

FAMILY / Species	Common Name	Community
ADIANTACEAE		
Cheilanthes austrotenuifolia	Green Rock Fern	2b 2c
AIZOACEAE		
Disphyma crassifolium	Rounded Noon-flower	2b 4c
Disphyma crassifolium subsp. *clavell.*	Rounded Noon-flower	2a 2c 3a 4a 4b 4c 4d
**Mesembryanthemum crystallinum*	Common Ice-plant	5b
**Psilocaulon tenue*	Wiry Noon-flower	1a 1e 3b 4a 4c
Tetragonia tetragonioides	New Zealand Spinach	1a 1c 1d 1e 2a 2c 2d 3a 3b 4a 4c 5a 5b
ALSTROMERIACEAE		
Dicrastylis verticillata		2c
AMARANTHACEAE		
Hemichroa diandra	Mallee Hemichroa	4c
Ptilotus atriplicifolius		1a 2a 2c 4a
Ptilotus erubescens	Hairy-tails	2a
Ptilotus exaltatus	Lamb-tails	1a 1c 1d 1e 2a 2b 2c 4a 4c
Ptilotus gaudichaudii		2c 4a
Ptilotus nobilis	Yellow-tails	2c
Ptilotus obovatus	Silver-tails	1a 1d 1e 2a 2c 4a
Ptilotus polystachyus	Long-tails	1c 2c 4c
Ptilotus seminudus	Rabbit-tails	1a 2c
Ptilotus sessilifolius var. *sessilifolius*	Crimson-tails	1a 2a 2c 3a 3b 4a
Ptilotus spathulatus	Pussy-tails	2a
APIACEAE		
Daucus glochidiatus	Austral Carrot	1a 1e 2a 2c 3a 3b 4a
ASCLEPIADACEAE		
Leichhardtia australis	Austral Doubah	1a 1c 1d 1e 2a 2c 4a
Rhyncharrhena linearis	Purple Pentatrope	1e 2c
ASTERACEAE		
Actinobole uliginosum	Flannel Cudweed	1a 1c 1d 1e 2c 3a 4a
Angianthus tomentosus	Hairy Angianthus	2c 4a
**Arctotheca calendula*	Cape Weed	1a
Aster subulatus	Aster-weed	4a
Brachyscome ciliaris	Variable Daisy	1a 1d 2a 2c 4a 4c
Brachyscome exilis	Slender Daisy	4c
Brachyscome lineariloba	Hard-head Daisy	1a 1c 1d 1e 2a 2c 3a 4a 4c
Brachyscome trachycarpa	Inland Daisy	4a
Bracteantha bracteata	Golden Everlasting	1a 1e 2a 2c 3a 4c
Calotis cymbacantha	Burr-daisy	1a 1c 1e 2a 4a
Calotis erinacea	Tangled Burr-daisy	2c
Calotis hispidula	Hairy Burr-daisy	1a 1c 1d 1e 2a 2c 3a 4a 5b
**Carthamus lanatus*	Saffron Thistle	2a 2c
**Centaurea melitensis*	Malta Thistle	1a 2a 4a 4b 5a 5b
Centipeda cunninghamii	Common Sneezeweed	4a 5a 5b
Centipeda minima	Spreading Sneezeweed	2a 4b
Centipeda thespidioides	Desert Sneezeweed	2a
**Chondrilla juncea*	Skeleton Weed	4a
Chrysocephalum apiculatum s.l.	Common Everlasting	2c
Chthonocephalus pseudevax	Groundheads	1a 3a 4a 4c
**Cirsium vulgare*	Spear Thistle	5b
**Conyza bonariensis*	Tall Fleabane	5b
Cotula australis	Common Cotula	1a
Cratystylis conocephala	Blue-bush Daisy	2a 2c
**Dittrichia graveolens*	Stinkweed	1e 2a 2c 4a 5b
Elachanthus glaber	Shiny Elachanth	4a
Eriochlamys behrii		4c
Euchiton sphaericus	Annual Cudweed	1a
Gnephosis arachnoidea		2a 2c
Gnephosis tenuissima	Dwarf Cup-flower	1a 1c 1d 2c 3a 4a
**Hedypnois cretica*	Cretan Hedypnois	
Hyalosperma demissum	Moss Sunray	4a
Hyalosperma stoveae	Dwarf Sunray	
**Hypochoeris glabra*	Smooth Cat's Ear	1a 1d 1e 2c 4a
**Hypochoeris radicata*	Cat's Ear	1a 1c 1d 1e 2c 3a 4a 4b 4c
Isoetopsis graminifolia	Grass Cushion	1a 1e 4a
Ixiolaena leptolepis	Narrow Plover-daisy	
Kippistia suaedifolia	Fleshy Minuria	2c 4a
**Lactuca serriola*	Prickly Lettuce	4a
Lemooria burkittii	Wiry Gnephosis	1a 3a
Millotia greevesii		2c
Millotia myosotidifolia	Broad-leaf Millotia	2c 3a
Minuria cunninghamii	Bush Minuria	4a
Minuria intergerrima	Smooth Minuria	4a
Myriocephalus rhizocephalus	Woolly-heads	4a
Myriocephalus stuartii	Poached-eggs Daisy	2a 2c 4a
Olearia muelleri	Mueller Daisy-bush	1a 1d 1e 2a 2b 2c 4a
Olearia pimeleoides	Pimelea Daisy-bush	1a 1c 1d 1e 2a 2b 2c 3a 4a 4c
Olearia subspicata	Spiked Daisy-bush	2b 2c
**Onopordum acaulon*	Stemless Onopordon	1a 2a 2c 2d 4a 4b
Podolepis capillaris	Wiry Podolepis	1a 1c 1d 1e 2a 2b 2c 2d 3b 4a 4c
Podotheca angustifolia	Sticky Longheads	1a 2c
Pogonolepis muelleriana	Stiff Cup-flower	1a
Pseudognaphalium luteoalbum	Jersey cudweed	2c 4a 5b
Pycnosorus pleiocephalus	Soft Billy-buttons	1a 1e
**Reichardia tingitana*	Reichardia	1a 1e 2a 2c 4a
Rhodanthe corymbiflora	Paper Sunray	4c
Rhodanthe floribunda		2c
Rhodanthe microglossa		1d
Rhodanthe moschata	Musk Sunray	1a 1c 1d 1e 2a 2c 2d 4a
Rhodanthe pygmaea	Pygmy Sunray	1a 1e 2c 4a
Rhodanthe stuartiana	Clay Sunray	4a
Rhodanthe tietkensii	Sand Sunray	2a
Senecio glossanthus	Slender Groundsel	1a
Senecio minimus	Shrubby Fireweed	1a 2c 3a 4c
Senecio pinnatifolius	Variable Groundsel	1a 1d
Senecio quadridentatus	Cotton Fireweed	4b 4c
Senecio runcinifolius	Tall Groundsel	4a
**Sonchus asper* s.l.	Rough Sow-thistle	1a 2a 5b
**Sonchus oleraceus*	Sow-thistle	1a 1d 1e 2a 2c 2d 3a 4a 4b
Stuartina muelleri	Spoon Cudweed	2a
Triptilodiscus pygmaeus	Common Sunray	1a 4a 4c
Vittadinia cuneata	Fuzzy New Holland Daisy	1a 1c 1d 1e 2a 2b 2c 3a 4a 4b
Vittadinia dissecta	Dissected New Holland Daisy	1a 2c
Waitzia acuminata var. *acuminata*	Orange Immortelle	1a 1d 2a 2c 3a
**Xanthium spinosum*	Bathurst Burr	1a 4a
BORAGINACEAE		
**Echium plantagineum*	Paterson's Curse	4a 5b
Halgania cyanea	Rough Halgania	1d 2c
Heliotropium curassavicum	Smooth Heliotrope	2a 4a
**Heliotropium europaeum*	Common Heliotrope	4b
**Heliotropium supinum*	Creeping Heliotrope	5b
Omphalolappula concava	Burr Stickseed	1a 1d 2a 2c 3b 4a 4c
Plagiobothrys plurisepalus	White Rochelia	1a 4a
BRASSICACEAE		
**Alyssum linifolium*	Flax-leaf Alyssum	1a 2a
Arabidella trisecta	Shrubby Cress	2a
**Brassica tournefortii*	Mediterranean Turnip	1a 2b 2d 4a
**Carrichtera annua*	Ward's Weed	1a 1d 2c 3a 4a
Geococcus pusillus	Earth Cress	3a
Harmsiodoxa blennodioides	May Smocks	1a 1c 2a 2c 3a 3b 4a 4c
Harmsiodoxa brevipes var. *brevipes*	Short Cress	1a 1c 1d 1e 4a
Lepidium leptopetalum	Slender Pepper-cress	1a 2a 2c 4a
Lepidium papillosum	Warty Pepper-cress	1a 4c
Lepidium phlebopetalum	Veined Pepper-cress	1a 2c
Menkea australis	Fairy Spectacles	4a
**Sisymbrium erysimoides*	Smooth Mustard	1e 2a 4a
**Sisymbrium irio*	London Mustard	1a 1c 1d 2a 2c 4a
**Sisymbrium orientale*	Indian Hedge Mustard	1a 2c
Stenopetalum lineare	Narrow Thread-petal	1a 1d 2c
Stenopetalum sphaerocarpum	Pea Thread-petal	1a 2c 4a 4c
CACTACEAE		
**Opuntia vulgaris*	Drooping Prickly Pear	
CAESALPINACEAE		
Senna artemisioides nothosp. *coriac.*	Broad-leaf Desert Cassia	1a 1d 1e 2a 2c 4a
Senna artemisioides subsp. *filifolia*	Fine-leaf Desert Cassia	1a 1d 1e 2a 2c 3a 4a
Senna artemisioides subsp. *petiolaris*	Phyllodinous Desert Cassia	1a 1d 1e 2a 2c 3a 4a
CAMPANULACEAE		
Wahlenbergia communis s.l.	Tufted Bluebell	2c 4a
Wahlenbergia gracilenta s.l.	Annual Bluebell	1a 1c 1d 2a 2c 3a 3b 4a 5b
Wahlenbergia gracilis s.l.	Sprawling Bluebell	4a
CARYOPHYLLACEAE		
Gypsophila tubulosa	Austral Chalkwort	1a 2a 2c 4a
**Herniaria cinerea*	Herniaria	1a 2c 4a
Scleranthus minusculus	Cushion Knawel	4a
**Silene apetala*	Sand Catchfly	4a
**Spergularia diandra*	Lesser Sand-spurrey	1a 3a 4a
**Spergularia rubra*	Red Sand-spurrey	1a 2a 2b 2c 3a 4a 4c 5b
CASUARINACEAE		
Casuarina pauper	Belah	1a 1d 1e 2a 2c 4a 4b 4c
CHENOPODIACEAE		
Atriplex acutibractea	Pointed Saltbush	1a 2a 2b 2c 4a 4b 4c
Atriplex eardleyae	Eardley's Saltbush	4c
Atriplex holocarpa	Large Pop Saltbush	4c
Atriplex lindleyi	Baldoo	4a
Atriplex lindleyi subsp. *inflata*	Corky Saltbush	4c
Atriplex nummularia	Old-man Saltbush	4a
Atriplex stipitata	Kidney Saltbush	1a 1b 1c 1d 1e 2a 2c 3a 4a 4b 4c
Atriplex suberecta	Sprawling Saltbush	1a
Atriplex vesicaria	Bladder Saltbush	1a 1c 1d 2a 2c 4a 4b 4c 4d
**Chenopodium album*	Fat Hen	5b
Chenopodium cristatum	Crested Goosefoot	1a 1c 1d 1e 2a 2c 2d 3a 4a 4b 4c 5b
Chenopodium curvispicatum	Cottony Goosefoot	1a 1b 1c 1d 1e 2a 2c 3a 4a 4c
Chenopodium desertorum	Frosted Goosefoot	1a 1c 1d 1e 2a 2b 2c 4a 4b
Chenopodium melanocarpum		5b
**Chenopodium murale*	Sowbane	1a 1d
Chenopodium nitrariaceum	Nitre Goosefoot	5a
Chenopodium ulicinum		1d 2a
Dissocarpus paradoxus	Hard-head Saltbush	1a 1c 1d 1e 2a 2b 2c 2d 3a 4a 4b 4c
Einadia nutans	Nodding Saltbush	1a 1c 1d 1e 2a 2b 2c 3a 3b 4a 4b
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush	1a 1b 1c 1d 1e 2a 2b 2c 2d 3a 3b 4a 4b 4c 5b
Eriochiton sclerolaenoides	Woolly-fruit Bluebush	1a 1d 2a 2c 4a
Halosarcia halocnemoides subsp. *halo.*	Grey Glasswort	2b 4a
Halosarcia indica	Brown-head Glasswort	2b 4a 4b 4c
Halosarcia lylei	Wiry Glasswort	2b 4c 4d
Halosarcia pergranulata	Black-seeded Glasswort	2a 2b 4a 4c 4d
Halosarcia pterygosperma subsp. *pteryg.*	Green Glasswort	2b 4c
Maireana appressa	Grey Bluebush	1a 2a 2c 4a 4b 4c
Maireana brevifolia	Short-leaf Bluebush	1a 1b 1c 1d 2a 2c 4a 4b 4c 5b
Maireana ciliata	Hairy Bluebush	1a
Maireana decalvans	Common Bluebush	1a 2a 2c
Maireana erioclada	Rosy Bluebush	4a
Maireana georgei	Slit-wing Bluebush	1a 1d 1e 2a 2b 2c 3a 4a 4c
Maireana integra		1a 2a 2c
Maireana lobiflora	Lobed Bluebush	4a
Maireana pentatropis	Erect Bluebush	1a 1c 1d 1e 2a 2b 2c 3a 3b 4a 4b 4c
Maireana pyramidata	Shrubby Bluebush	1a 2a 3a 4a 4c
Maireana radiata	Radiant Bluebush	1a
Maireana sedifolia	Hoary Bluebush	1a 1d 2a 2c 4a
Maireana trichoptera	Hairy-wing Blue-bush	1a 1d 2a 2b 2c 4a
Maireana triptera	Three-winged Bluebush	1a 1d 2a 2c 3a 4a
Maireana turbinata	Satiny Bluebush	1a 2a 2c 4c
Malacocera tricornis	Goat-head	1a 3a
Osteocarpum acropterum var. *demin.*	Babbagia	1c 2a 2b 4a 4c 4d
Rhagodia spinescens	Hedge Saltbush	1a 1d 2a 2c 4a
Rhagodia ulicina	Spiny Saltbush	1a 1d 2a 2c 4a 4c
Salsola kali	Prickly Saltbush	1a 1c 1d 1e 2a 2c 2d 4a 4b 4c
Sclerolaena bicornis		1a 1c 2a 2b 2c 2d 3a 4a 4b
Sclerolaena decurrens	Green Bassia	4a 4c
Sclerolaena diacantha	Horned Bassia	1a 1c 1d 1e 2a 2b 2c 3a 4a 4b 4c
Sclerolaena divaricata	Tangled Bassia	1a 3a 4c
Sclerolaena muricata	Five-spined Bassia	2c 5b
Sclerolaena obliquicuspis	Oblique-spined Bassia	1a 1b 1c 1d 1e 2a 2b 2c 2d 3a 3b 4a 4b 4c
Sclerolaena parviflora	Small-flower Bassia	1d 2a 2c
Sclerolaena patenticuspis	Spear-fruit Bassia	1a 1b 1d 1e 2a 2b 2c 3b 4a 4c 5b
Sclerolaena tricuspis	Three-spined Bassia	1a
Sclerostegia tenuis	Slender Glasswort	4b 4c
Suaeda australis	Austral Seablite	4a
CONVOLVULACEAE		
Convolvulus erubescens	Pink Bindweed	1e 2a 2c 4a 4b
CRASSULACEAE		
Crassula colorata	Dense Crassula	1a 1c 1d 1e 2a 2c 3a 4a 4c
CUCURBITACEAE		
**Citrullus colocynthis*	Colocynth	
**Cucumis myriocarpus*	Paddy Melon	1a 1e 2a 2c 2d 4a
CUPRESSACEAE		
Callitris glaucophylla	White Cypress-pine	1a 1c 1d 4a 4c
Callitris verrucosa	Scrub Cypress-pine	2b 2c
CYPERACEAE		
Schoenus subaphyllus	Desert Bog-sedge	2c
DILLENIACEAE		
Hibbertia virgata	Twiggy Guinea-flower	2b
ELATINACEAE		
Bergia trimera	Three-part Water-fire	4a
EUPHORBIACEAE		
Beyeria opaca	Dark Turpentine Bush	1d 2a 2b 2c 3a 4a
Chamaesyce drummondii	Flat Spurge	1a 1c 1d 1e 2a 2c 2d 4a 4b 5a 5b
Poranthera microphylla	Small Poranthera	1a
FABACEAE		
Daviesia ulicifolia	Gorse Bitter-pea	2c
Eutaxia diffusa/microphylla	Spreading/Common Eutaxia	1d 2b 2c
Glycyrrhiza acanthocarpa	Southern Liquorice	4a
**Medicago laciniata*	Cut-leaf Medic	1a 2c 4a
**Medicago minima*	Little Medic	1a 1b 1c 1d 1e 2a 4a 4b 5a
**Medicago polymorpha*	Burr Medic	1a 4a 5b
**Melilotus indicus*	Sweet Melilot	4a
Swainsona purpurea	Purple Swainson-pea	4a
Templetonia egena	Rough Templetonia	1a 1d 1e 2a 2c 4a
FRANKENIACEAE		
Frankenia connata		2b
Frankenia foliosa	Leafy Sea-heath	2a 2b 4a 4c
Frankenia gracilis		4b
Frankenia pauciflora subsp. *pauciflora*	Southern Sea-heath	1a 3a 4b
Frankenia serpyllifolia	Slender Sea-heath	4c
GENTIANACEAE		
**Centaurium spicatum*	Spike Centaury	5b
**Centaurium tenuiflorum*	Branched Centaury	1a 4a
GERANIACEAE		
**Erodium botrys*	Big Heron's Bill	4a
**Erodium cicutarium*	Common Heron's-bill	1a 2a 2c 3a 4a 5b
Erodium crinitum	Blue Heron's-bill	1a 1c 1d 1e 2c 3a 4a 4c
GOODENIACEAE		5b
Goodenia fascicularis	Silky Goodenia	1a 1c 1d 2c 3a 4a
Goodenia pinnatifida	Cut-leaf Goodenia	1a 1d 4a
Goodenia pusilliflora	Small-leaf Goodenia	1a 1e 2a 2c 3a 3b 4a 4b 4c
Scaevola depauperata	Skeleton Fan-flower	2b 2c
Scaevola spinescens	Prickly Fan-flower	1a 1d 2a 2b 2c 4a
GYROSTEMONACEAE		
Codonocarpus cotinifolius	Bell-fruit Tree	2c
HALORAGACEAE		
Glischrocaryon behrii	Golden Pennants	2c
Haloragis aspera	Rough Raspwort	2c
Haloragis odontocarpa	Toothed Raspwort	2b 2c
Myriophyllum verrucosum	Red Milfoil	4a
JUNCAGINACEAE		
Triglochin calcitrapum	Spurred Arrow-grass	1a 3a
LAMIACEAE		5b
**Marrubium vulgare*	Horehound	1b 2a 4a 5b
**Salvia verbenaca*	Wild Sage	1a 1b 2a 2c 4a
Teucrium racemosum var. *racemosum*	Grey Germander	1a 2a 2c 4a 4b 5a
Westringia rigida	Stiff Westringia	1a 2a 2b 2c 4a
LAURACEAE		
Cassytha melantha	Coarse Dodder-laurel	1a
LILIACEAE		
Bulbine bulbosa	Yellow Bulbine-lily	1a 3a 4a 4c
Dianella revoluta	Black-anther Flax-lily	2c
Thysanotus baueri	Mallee Fringe-lily	2c 4a 4c
LOGANIACEAE		
Logania nuda	Bare Logania	2c
LORANTHACEAE		
Amyema linophyllum subsp. *orientale*	Buloke Mistletoe	1a 2a 4a
Amyema miquelii	Box Mistletoe	1a 2a 2c
Amyema miraculosum subsp. *boormanii*	Fleshy Mistletoe	1a 1d 1e 2a 2c 4a
Amyema preissii	Wire-leaf Mistletoe	1a 1e 2a 2b 2c 2d 3b 4a
Lysiana exocarpi subsp. *exocarpi*	Harlequin Mistletoe	1a 1e 2a 2c 3a
MALVACEAE		
Abutilon fraseri	Dwarf Lantern-bush	1a 2a 4a 5b
Lawrencia glomerata	Clustered Lawrencia	4c
Lawrencia squamata	Thorny Lawrencia	2a 4a 4b 5b
**Malva parviflora*	Small-flowered Mallow	2a 2c
**Modiola caroliniana*	Carolina Mallow	1a
Radyera farragei	Desert Rose Mallow	2a
Sida corrugata var. *corrugata*	Variable Sida	1a 1c 1d 1e 2a 2c 4a 4b
Sida intricata	Twiggy Sida	2a 2c 4a
MARSILEACEAE		
Marsilea angustifolia		4a
Marsilea costulifera	Narrow-leaf Nardoo	4a 5b
Marsilea drummondii	Common Nardoo	1a 4a 5a
MIMOSACEAE		
Acacia acanthoclada	Harrow Wattle	2c
Acacia aneura		1a 2c 3a 4c
Acacia brachybotrya	Grey Mulga	1a 2a 2c
Acacia burkittii		1a 1e 2a 2b 2c 3a 3b 4a 4c
Acacia colletioides	Wait-a-while	1a 1d 1e 2a 2b 2c 4a 4b
Acacia ligulata	Small Cooba	2c
Acacia loderi	Nealie	1a 1d 2c 3b 4a
Acacia oswaldii	Umbrella Wattle	1a 1d 1e 2a 2b 2c 4a
Acacia rigens	Nealie	1a 1d 2a 2b 2c
Acacia sclerophylla	Hard-leaf Wattle	2a 2c 4b 4c
Acacia stenophylla	Eumong	4a
Acacia victoriae subsp. *victoriae*	Bramble Wattle	4a
Acacia wilhelmiana	Dwarf Nealie	1d 2c 4a
MYOPORACEAE		
Eremophila deserti	Turkey-bush	1a 1d 1e 2b 2c 4a
Eremophila divaricata subsp. *divaricata*	Spreading Emu-bush	
Eremophila glabra	Common Emu-bush	1a 1c 1d 1e 2a 2b 2c 2d 3a 4a
Eremophila hillii		1a 2a 2c
Eremophila longifolia	Berrigan	2c
Eremophila maculata var. *maculata*	Spotted Emu-bush	1a 2c
Eremophila oppositifolia subsp. *opposit.*	Twin-leaf Emu-bush	1a 1e 2c 4a
Eremophila scoparia	Silvery Emu-bush	1a 1d 2a 2b 2c 3a 4a
Eremophila sturtii	Narrow-leaf Emu-bush	1a 1b 1c 1d 1e 2a 2b 2c 2d 3a 4a
Myoporum platycarpum	Sugarwood	1a 1c 1d 1e 2a 2c 4a
MYRTACEAE		
Baeckea crassifolia	Desert Baeckea	2c
Eucalyptus costata/incrassata	Yellow Mallee	2c
Eucalyptus dumosa	Dumosa Mallee	1a 1d 2a 2b 2c 4a
Eucalyptus gracilis	White Mallee	1a 1d 2a 2b 2c 3a 4a 4b 4c
Eucalyptus largiflorens	Black Box	1b
Eucalyptus leptophylla	Slender-leaf Mallee	2b 2c 4a
Eucalyptus oleosa	Oil Mallee	1a 2a 2c 4a
Eucalyptus porosa	Black Mallee Box	2d
Eucalyptus socialis	Grey Mallee	1a 1d 1e 2a 2b 2c 4a 4b
Leptospermum coriaceum	Green Tea-tree	2b 2c
Melaleuca lanceolata	Moonah	2b 2c 4c
NYCTAGINACEAE		
Boerhavia dominii	Tah-vine	1a 2d
OLEACEAE		
Jasminum didymum subsp. *lineare*	Desert Jasmine	1a 2c 4a
ORCHIDACEAE		
Pterostylis biseta s.l.	Rusty-hood	4a
OXALIDACEAE		
Oxalis perennans	Grassland Wood-sorrel	1a 1e 2a 2c 3a 3b 4a 4b 4c 5a
**Oxalis pes-caprae*	Soursob	1a 5b
PITTOSPORACEAE		
Billardiera cymosa	Sweet Apple-berry	4a
Pittosporum phylliraeoides	Weeping Pittosporum	1a 1e 2c 4a
PLANTAGINACEAE		
Plantago cunninghamii	Clay Plantain	1a 2c 4a
Plantago drummondii	Dark Plantain	5b
Plantago varia	Variable Plantain	1a 3a 4a 4c
POACEAE		
Agrostis avenacea	Common Blown Grass	4a 5b
Amphipogon caricinus var. *caricinus*	Long Grey-beard Grass	1a 2b 2c 4a
Aristida contorta	Sand Wire-grass	1a 2c 3a 4a 4c
Bromus arenarius	Sand Brome	4a 4c
**Bromus rubens*	Red Brome	1a 1c 1d 1e 2c 4a 4c 5b
Chloris truncata	Windmill Grass	1a 1d 2a 2c 5b
**Critesion murinum* subsp. *leporinum*	Wall Barley-grass	1a 1c 1d 1e 2a 2c 4a 4c
Cynodon dactylon	Couch	5b
Danthonia eriantha	Hill Wallaby-grass	1a 2b 2c
Danthonia setacea	Bristly Wallaby-grass	1a 1c 1d 1e 2a 2b 2c 4a
Enneapogon intermedius		1a 1e 2b 2c 5b
Eragrostis australasica	Cane Grass	5a
Eragrostis dielsii	Mallee Love-grass	1a 1c 2a 2b 2c 3a 4a 4b 4c
Eragrostis eriopoda		2b 2c
Eragrostis falcata	Sickle Love-grass	1a
Eragrostis setifolia	Bristly Love-grass	4d
**Holcus lanatus*	Yorkshire Fog	1a 2c 2d
**Panicum capillare*	Witch-grass	1a 2c 4a
Paspalidium gracile	Slender Panic	1a 1d 1e 2a 2b 2c 3a 4a 4b
**Rostraria pumila*	Tiny Bristle-grass	1a 1c 1e 2c 3a 4a 4b 4c
**Schismus barbatus*	Arabian Grass	1a 1c 1d 1e 2a 2c 2d 3a 3b 4a 4c 5a
Stipa drummondii	Cottony Spear-grass	1a 1e 2a 2c 4c
Stipa elegantissima	Feather Spear-grass	1a 1d 2a 2b 2c 4a 4b
Stipa scabra subsp. *scabra*	Rough Spear-grass	1a 4a
Stipa spp.		1a 1c 1d 1e 2a 2b 2c 3a 3b 4a 4b 4c
Triodia scariosa subsp. *scariosa*	Rough Porcupine Grass	1a 1d 2a 2b 2c
**Vulpia myuros*	Rat's-tail Fescue	1a 1e 3a 4a
POLYGONACEAE		
**Emex australis*	Spiny Emex	5b
Muehlenbeckia diclina	Twiggy Lignum	4a
Muehlenbeckia florulenta	Tangled Lignum	2b
Polygonum plebeium	Small Knotweed	4c 5b
**Rumex crispus*	Curled Dock	5b
Rumex tenax	Shiny Dock	5b
PORTULACACEAE		
Calandrinia eremaea	Small Purslane	1a 1c 1d 1e 2a 2c 3a 3b 4a 4b 4c
PRIMULACEAE		
**Anagallis arvensis*	Pimpernel	5b
PROTEACEAE		
Grevillea huegelii	Comb Grevillea	1a 1d 2a 2b 2c 4a
Grevillea pterosperma	Desert Grevillea	2c
Hakea leucoptera	Silver Needlewood	1a 1c 1d 2a 4a 4c
Hakea tephrosperma	Hooked Needlewood	1a 1e 2a 4a
RANUNCULACEAE		5b
Ranunculus pumilio	Fan-leaf Buttercup	4a
RHAMNACEAE		
Cryptandra propinqua	Silky Cryptandra	2a
RUBIACEAE		
Asperula conferta	Common Woodruff	4a
Synaptantha tillaeaceae		1a 2a 4a
RUTACEAE		
Geijera parviflora	Wilga	1a 1d 1e 2a 2c
SANTALACEAE		
Exocarpos aphyllus	Leafless Ballart	1a 1d 1e 2a 2c 4a 4b
Exocarpos sparteus	Broom Ballart	1a 4a
Santalum acuminatum	Sweet Quandong	1a 1e 2c
SAPINDACEAE		
Alectryon oleifolius subsp. *canescens*	Cattle-bush	1a 1b 1c 1d 1e 2a 2c 4a
Dodonaea bursariifolia	Small Hop-bush	1a 2c
Dodonaea viscosa subsp. *angustissima*	Narrow-leaf Hop-bush	1a 1c 1d 1e 2a 2b 2c 3a 4a 4b 4c
SCROPHULARIACEAE		
Limosella australis	Austral Mudwort	2c 5b
Morgania floribunda	Blue Rod	1a 2a 4a
SOLANACEAE		
Datura stramonium	Common Thorn-apple	4a
Duboisia hopwoodii		1a 2c 4a
Lycium australe	Australian Box-thorn	1a 1d 2a 2b 2c 3a 4a 4b 4c 5a
**Lycium ferocissimum*	African Box-thorn	5b
**Nicotiana glauca*	Tree Tobacco	1b 4a
Nicotiana goodspeedii	Smooth-flower Tobacco	1a 4c
Nicotiana occidentalis		2c 5b
Nicotiana simulans		1a 1d 2a 2c 4a
Nicotiana velutina	Velvet Tobacco	2b 2c 3a 3b 4a 4c
Solanum coactiliferum	Western Nightshade	2a 2c
Solanum esuriale	Quena	1a 1e 2a 2b 2c 4a 5b
**Solanum nigrum*	Black Nightshade	1a 1e 2a 2c 2d 3b 4a
THYMELAEACEAE		
Pimelea microcephala subsp. *microceph.*	Mallee Rice-flower	1a 1c 1e 2a 2c 4a
Pimelea simplex subsp. *simplex*	Desert Rice-flower	2c 4a
Pimelea trichostachya	Annual Rice-flower	1a 2a 2c 4a
Pimelea williamsonii	Williamson's Rice-flower	1c 4a 4c
TYPHACEAE		
Typha domingensis	Cumbungi	4a
URTICACEAE		
Parietaria debilis	Shade Pellitory	4a
Urtica urens	Small Nettle	4a
VERBENACEAE		5b
**Verbena supina*	Trailing Verbena	1a 2a
XANTHORRHOEACEAE		
Lomandra effusa	Scented Mat-rush	2a
Lomandra leucocephala subsp. *robusta*	Woolly Mat-rush	2b 2c 4b
ZYGOPHYLLACEAE		
Nitraria billardierei	Nitre-bush	1a 2a 2b 3a 4a 4b 4c
Tribulus terrestris	Caltrop	5b
Zygophyllum ammophilum	Sand Twin-leaf	1a 1c 1d 2a 2c 2d 3a 3b 4a 4c
Zygophyllum apiculatum	Pointed Twin-leaf	1a 2a 2c 4a
Zygophyllum aurantiacum	Shrubby Twin-leaf	1a 1e 2a 2c 4a
Zygophyllum billardieri	Coast Twin-leaf	1a 1d 1e 2a 2c
Zygophyllum crenatum	Notched Twin-leaf	1a 2c
Zygophyllum eremaeum	Desert Twin-leaf	1a 1d 2a 2c 4a
Zygophyllum glaucum	Pale Twin-leaf	2a 2c
Zygophyllum iodocarpum	Violet Twin-leaf	1a 2a 2c 4a
Zygophyllum ovatum	Dwarf Twin-leaf	1a 2a 2c

Species list for the Scotia 1:100 000 map sheet, western New South Wales

Species are listed alphabetically by family then genus. The alphanumeric codes are the communities as mapped, in which the species was recorded.

Asterisks (*) denote exotic species.

CUNNINGHAMIA

A journal of plant ecology

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